

FIRST LOOK: ASUS' NEW WATER-COOLED GAMING LAPTOP



CUSTOM PC

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Welcome

Custom PC Issue 151

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Contents

Welcome to Issue 151

82 Build an overclocked Skylake gaming PC

FOR £596 INC VAT

If you want a new PC to play the latest games, but don't have the big bucks for a top-end gaming rig, you're going to love this issue. We not only show you how to build a sub-£600 PC, but we'll also show you how to overclock it, resulting in a machine that can play current games at Ultra settings.

Thanks to some nifty BIOS tweaking by the engineers at various motherboard makers, you can overclock the base clock of any Skylake CPU, whether or not its name has a K on the end. By all accounts, Intel is apparently pretty grumpy about the situation, and it may well crack down on it in the future, but at the moment, you can effectively get a 4.4GHz Skylake CPU for just £93.

COVER STORY
P82



Highlights

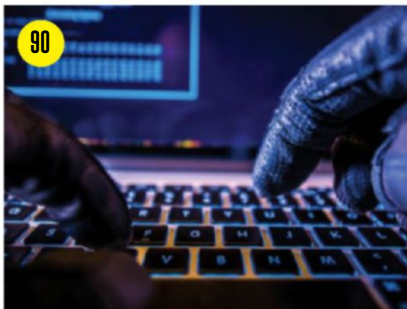
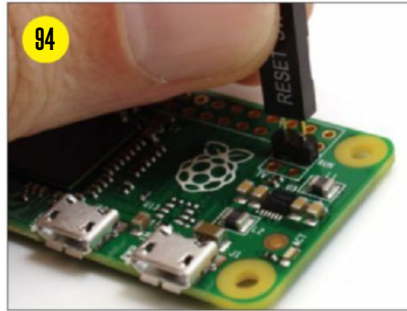
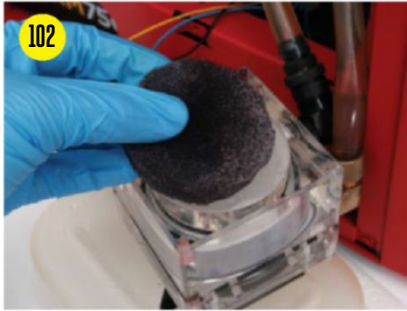
- 10** External graphics cards
Richard Swinburne wants Razer's new external graphics card system
- 14** Star Wars is all about me
Tracy King asks if Star Wars fans are really more likely to be narcissists.
- 17** Asus GX700
We get our hands on Asus' new water-cooled gaming laptop.
- 18** Intel Core i3-6100
The star of our cover feature – a dual-core Skylake CPU with Hyper-Threading that's currently overlockable.
- 24** Mini-ITX liquid cooling
We try out Corsair's new H5 SF, an all-in-one liquid cooler designed to be housed in a small mini-ITX case.



- 36** 4K monitor Labs
We review ten 4K displays to find the best ones for your needs.
- 44** Dell's 5K monitor
We feast our eyes on the UltraSharp UP2715K's 5,120 x 2,880 resolution.
- 90** Cyberbullying
Online abuse in gaming and on social media is widespread and severe. Rick Lane analyses why it happens and how it can be stopped.



- 98** Make a Raspberry Pi Zero reset switch
Gareth Halfacree takes you through the process of adding a reset switch to a Raspberry Pi zero, using the RUN header.
- 102** How to clean your water-cooling loop
Time to change your coolant and clean your water-cooling parts? Antony Leather shows you how it's done.



Regulars

- 8 From the editor
- 10 Richard Swinburne
- 12 Letters
- 14 Tracy King
- 15 Incoming
- 30 Custom kit
- 34 How we test
- 56 PC system reviews
- 62 Elite products
- 73 Inverse look
- 80 The engine room
- 94 Hobby tech
- 100 Customised PC
- 102 How to guides
- 108 Readers' drives
- 112 RealBench leaderboard
- 113 Your folding milestones
- 114 James Gorbald

Cover guide



35
PRODUCTS
REVIEWED

Reviewed this month

Reviews

GAMING LAPTOP

17 Asus GX700

CPU

18 Intel Core i3-6100

MOTHERBOARD

20 Asus Maximus VIII Formula

CPU COOLER

24 Corsair H5 SF

MINI-ITX CASE

26 In Win Chopin

GAMING MOUSE

28 QPAD DX-20

Custom kit

- 30 Enerplex JumpStack 9
- 30 Jabra Sport Coach
- 30 Codenames
- 31 ZX Spectrum Vega
- 31 Cobra JumpPack
- 31 Startech Bluetooth Audio Receiver with NFC

Monitor Labs

- 38 Acer S277HK
- 39 AOC U2879VF
- 40 Asus PB279Q
- 42 Asus ROG Swift PG27AQ
- 43 BenQ BL2420U
- 44 Dell UltraSharp UP2715K
- 46 Iiyama G-Master GB2888UHSU
- 48 Iiyama ProLite X4071UHSU
- 50 Philips Brilliance BDM3275UP
- 52 Philips Brilliance BDM3490UC
- 53 Samsung UE32850R
- 54 ViewSonic VP2780-4K

PC system reviews

- 56 Computer Planet Fusion X7 GT
- 58 Oblivion Systems Guardian
- 60 Scan 3XS Z170 Vengeance Q

Games

- 74 Helldivers
- 76 Homeworld: Deserts of Kharak
- 76 Dragon's Dogma: Dark Arisen
- 78 The Beginner's Guide

Hobby tech

- 94 LeMaker Guitar
- 96 Pimoroni Explorer pHAT, £10
- 97 Pimoroni Scroll pHAT, £10
- 97 Pimoroni pHAT DAC, £12

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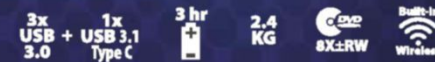
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BEN HARDWIDGE / FROM THE EDITOR

THE END OF CHEAP GPUS

Nvidia has lost the battle against integrated graphics, argues Ben Hardwidge

There are two main complaints I hear from former PC gamers who have retired to the console life, never to return to our glorious haven of dazzling graphics and proper controls. The first is the amount of money required to keep up with the relentless update cycle. The second is that they once bought a cheap graphics card, but then found it couldn't play any of their games properly. It's what happens when people insist on advertising cheap GPUs, such as Nvidia's newly announced GeForce GT 710 (see p15), as gaming cards.

Nvidia reckons the GT 710 is up to 80 per cent faster than some integrated graphics setups in games, which sounds impressive, but it's irrelevant when the original frame rate is so low that it's practically worthless anyway. I saw a graph on one Nvidia board partner's website, which showed the GT 710's performance being double that of the Intel HD Graphics system in the Pentium G3220 in 3DMark 11, but without quoting any figures. Let's face it, if the Pentium G3220's graphics system manages 3fps in a game, but the GT 710 manages 6fps, neither result is actually useful in any way.

The Pentium G3220 is also hardly the last word in integrated graphics anyway, especially when AMD's top-end APUs have half-decent Radeon GPUs, and when even Intel's latest Iris graphics systems are surprisingly powerful. If the best you can say about your graphics card is that it's twice as fast as the miniscule IGP in a sub-£50 CPU that came out in 2013 then your graphics card probably stinks.

Basically, if you want to build a dirt-cheap system for light gaming, you're better off buying an AMD APU. There isn't even

any point in buying a discrete graphics card for high-resolution monitor output (the GT 710 won't output to 4K at 60Hz, in case you were wondering), or video playback – the GT 710 won't offer you anything you can't get from an AMD APU in these respects.

Releasing the GT 710 now is like producing a typewriter with more keys, in the hope that it can take on the word processor. Nvidia has lost this battle – there's simply no point in buying a new low-end discrete graphics card any more, and I'm glad to see the back of these cards.

The GT 710 is similar to its predecessors in a lot of ways. It's

available in low-profile configurations with passive coolers, and its specs are so restricted that it will be next to useless in many games anyway, but you wouldn't know the latter from the product descriptions.

One of the major issues with these cards has always been the way the marketing spins the specifications to make them appeal to people who are uninformed. They make boasts about supporting PhysX and DirectX 12, and they have big numbers on the box, touting the card's '192 cores' and 2GB of memory. And some people understandably think those numbers make the cards worth buying, not realising that the memory is slow DDR3 RAM that's stuck behind a narrow 64-bit memory interface, which is a bit like building a fence between the memory and the GPU.


These low-end cards aren't built for gaming and, anecdotally, I've known several people in the past who have given up on PC gaming after buying them. I'll be very interested to see how GT 710 cards sell; I suspect and hope it will be one of the last low-end discrete GPU setups to be launched. **GPU**

It's a bit like building a fence between the memory and the GPU


Ben Hardwidge is the editor of Custom PC. He likes PCs, heavy metal, real ale and Warhammer 40,000. editor@custompcmag.org.uk [@custompcmag](https://twitter.com/custompcmag)



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RICHARD SWINBURNE / VIEW FROM TAIWAN

THINK OUTSIDE THE BOX

After years of external graphics cock-ups, Razer has finally made one that's worth buying, reckons Richard Swinburne

Tech manufacturers have been trying to make external graphics systems for years, and they've always failed, but this year someone finally got it right. Let's start with a little history.

I saw one of the first serious attempts at external graphics at CES 2007 from Asus, called the XG Station. It featured a strange, orange L-shaped housing with a dial and LED display that could adjust the settings of the enclosed GeForce 8600 GT (later a GeForce 7900 GS). This box was connected to the PC via an ExpressCard – a single 1x PCI-E connection providing a pedestrian bandwidth of 250MB/sec.

Fast forward to 2010 and, just ahead of Computex, I was among the first to see MSI's GUS (graphics upgrade system) concept. It used a similar ExpressCard system, but it was upgraded (ahem) to 1x PCI-E 2, offering 500MB/sec of bandwidth and a Radeon HD 5670 inside. A year or so later, MSI revised it and replaced its plastic case with a swish aluminium one that featured Intel's then-new Thunderbolt connection. Despite the performance upgrade, though, it also never saw the light of day.

In 2011, Sony finally managed to make a real external graphics product. Its premium Vaio-Z squeezed a mobile Radeon HD 6650 into a slim docking station that connected to a tiny 13.1in ultrabook via Thunderbolt. The limitations were significant though. There was no way to upgrade the mediocre graphics chip, and it only worked with a single, £2,000 Sony laptop. Yikes!

Roll on a few years to Computex 2014 and Asus was back, cooperating with SilverStone to show off its new SG Station. It was an aluminium box a little like SilverStone's FT03 Mini, making it significantly larger than any previous attempts, and it was connected via Thunderbolt 2 at 2.5GB/sec. However, behind the scenes, there was an impasse between the respective

driver teams in Intel's Thunderbolt division, and Nvidia and AMD's graphics driver teams, which prevented the necessarily validation effort to get it working reliably.

Now we've hit 2015 and Alienware has launched its subwoofer-sized Graphics Amplifier box at CES. We now have a real product that can accommodate any full-sized graphics card, but it uses a custom cable that can only hook up to a few Alienware laptops. MSI followed with its Gaming Dock Station, which had similarly ample proportions, and MSI then suggested the laptop should directly dock on top of it, leaving it raised

150mm above the desk. MSI was quick to reason that, when docked, it becomes a desktop replacement and the user then interfaces with a desktop setup with an external keyboard, mouse and monitor.

After all these limited or failed results, CES 2016 saw a change of wind in potential products, partly thanks to USB-C and Thunderbolt 3, which have finally got me really excited! Firstly, Asus' XG Station 2 is a large, G20-styled box that pipes Thunderbolt 3 over USB-C. It can even charge

your laptop and will (finally, for Thunderbolt) let you plug or unplug it on the fly.

However, it's Razer's new Blade Stealth that really nails it. Razer marries a sub-\$1,000 13in cutting-edge ultrabook with a moderately sized, cleverly designed USB-C/Thunderbolt 3 box that can house a full-sized graphics card. It can power the internal display or an external monitor and, like the XG Station 2, it can also charge the laptop.

Razer is very clear about the work/play split. Instead of trying to pair its box with a flashy, bling-tastic gaming laptop, Razer has designed the Blade Stealth for professionals on the move. Then, when you get back home you can dock it and start playing. Awesome! **CPG**

There was no way to upgrade the mediocre GPU, and it only worked with a single, £2,000 Sony laptop. Yikes!

Richard has worked in tech for over a decade, as a UK journalist, on Asus' ROG team and now as an industry analyst based in Taiwan @Bindibadgi



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Happy New Year. I Love Custom PC and the varied articles – much more interesting than the ‘latest M\$ W10 tweak’ and so on that I see in other magazines. I’m not exactly into modding, but I’ve managed to break two blades off one of my front Corsair Obsidian 750D case fans. Lesson learned – don’t go poking about when the computer is switched on ... duh!

Anyway, I’ve been looking for a replacement, a nice LED one perhaps, except the choice is overwhelming – different companies use different specs, so it’s hard to compare between them and opinion is widely divided about what’s best. I was hoping find a fan that was pretty but still as effective as my current case fans, while also being quieter and not too expensive. I’m not interested in overclocking, as it uses too much electricity.

My current system uses an ASRock X99X Killer motherboard, a Core i7-5930K CPU with a Corsair H105 cooler, 16MB of quad-channel memory, a Samsung XP941 256GB M.2 NGFF PCI-E SSD, Seagate 2TB and 3TB hybrid hard drives, 2 x MSI GTX 970 cards in SLI, a pioneer BDXL Blu-ray drive and Lite-On DVD drives. I play a lot of Battlefield 4 (looking forward to the release of Descent Underground) and my machine can get a bit hot sometimes. Could you recommend any fans, or do a Labs test, please?

DR DAVID PLEWS

Ben: We’ve had several similar requests for a case fan Labs test over the past year or so, and I think it’s about time we did it. I’ll look into the possibility of doing one this year. Assuming that you need some buying advice sooner, though, the key factors to consider are



Larger fans enable you to push out the same amount of air as smaller fans, but at lower (and therefore quieter) speeds

the fan speed and how much air it will push or pull through your system. As a general rule, larger fans are better than smaller ones – a 140mm fan can either push out more air than a 120mm fan when running at the same speed, or the same amount of air at a much lower (and quieter)

speed. On a personal level, I’ve always liked Noctua, Fractal and BeQuiet!’s case fans for balancing performance and noise, and Corsair has a wide range of fans made for specific requirements as well.



Running costs don’t matter

That was an interesting article about the power usage of gaming PCs, but I thought it was a little bizarre for you guys.

Okay, some good points were made generally about the price of electricity, the size of the boxes and components, and the required

If you can afford to buy a Ferrari in the first place, the price of fuel is irrelevant



extra power as GPUs and CPUs get overstressed. Thinking about cooling when building a big rig is important, naturally.

However, as a Custom PC enthusiast and system builder, I build a PC to be either quiet for media/storage duties, or huge and powerful for gaming. I couldn’t care less about their power efficiency – in my opinion, a PC uses the power it needs to do the job. As an analogy, if I can afford to buy a Ferrari in the first place, the price of fuel is irrelevant. In all my years building rigs for people, I’ve never once been asked about how much it will cost to run – it never happens.

JONAH LLOYD

Ben: A fair point – we all have different priorities, and if someone does indeed want an incredibly fast PC that costs lots of money, then power efficiency won’t be their top priority, if it even factors into their buying decision at all. However, the power a PC needs to do its job, as you put it, does vary wildly depending on what components you use, and that’s the crucial difference between AMD’s current gear and that of the competition. You’ll need to use significantly more power to run a top-end AMD FX rig with two Radeon R9 390X cards than a Skylake system with a pair of GTX 980 cards, but the performance would be similar.



Small screen upgrades

I’ve recently updated my PC system, and gone for a GeForce GTX 970 graphics card. My 22in 1,920 x 1,080 monitor is almost five years old now, and seems capable enough, but would I do more justice to my new graphics card with a newer monitor? My desk space is limited, so a 22-24in

Lesson learned – don't go poking about when the computer is switched on!



AOC's 24in G2460PG supports Nvidia's G-Sync tech and costs just £286 inc VAT

monitor would be ideal, and most monitors this size seem still to have a 1,920 x 1,080 resolution. What would you recommend?

DAVID D'ARCY

Ben: You can certainly get more out of your graphics card – in our tests, that GPU can play even demanding games at 2,560 x 1,440, and with decent settings too. We're also finally starting to see more smaller monitors with larger resolutions.

For example, the BenQ BL2420U on p43 has a 24in diagonal, but a massive 3,840 x 2,160 resolution. That's too much for your GPU in some games, but it shows that monitor makers are taking the prospect of high-resolution, smaller monitors seriously. There are benefits to buying such a display over a larger one too, as you end up with much smaller pixels and a sharper-looking picture.

In your situation, I'd consider buying a display such as the Dell P2416D, which has an IPS panel, a 2,560 x 1,440 resolution and a 24in diagonal. Bear in mind that this recommendation comes from spec alone though – we haven't given this monitor a proper review.

Twitter highlights

Follow us on Twitter at @CustomPCmag

sirbenjaminunn Can you fix the download link on the RealBench leaderboard? Want the latest version. Thanks!
Ben: Hopefully the download link on the Asus site will be fixed by the time this issue of the mag is in your hands, but just in case it's still down, we've made version 2.42 of our RealBench 2015 suite available via Dropbox at <http://tinyurl.com/CPCRealBench2015>

Lincoln_Ess Thank you for the decoding M.2 and NVMe guide. As a rookie to all this, it has helped clear some of the confusion!
Ben: You're very welcome – M.2 is a very confusing mess at the moment.

hawkes_lewis Great opening from Mr Hardwidge #overclocking was about getting something cheap and spanking the elite, remember the Intel 805D!
Ben: Thank you, and yes I love the fact that you can now build a 4.4GHz PC for under £600, as shown in our feature this month – much more exciting than spending lots of money on an unlocked CPU that's already fast.

Pc_Shed 29 days folding and 36M points over 2,407 WU for @CustomPCMag @bittech folding team. PPD 2.2M points at 75th place!

SkymurPro It's that time of the month again where happiness is delivered through your door.

richardnpaul Not long to go now. Looking forward to seeing how far this will get me up the leaderboard
Ben: Very nice! I see your Xeon rig has already got you onto the leaderboard on p112.

RSMarchant Reading the latest issue of @CustomPCMag and now trying to figure out where I would find £3,414 for the @OverclockersUK Infin8 Toxicity.

Ben: Wow, that's some serious folding power – fantastic stuff – I'll ask our resident folding chap Simon to get in touch so we can do a little profile on you in our next issue! It looks like you started your big folding push just after Simon collated the stats for this issue, but you should see the results of your hard work in next month's leaderboard.

One other option I'd consider is sticking with your 1080p resolution, but buying a G-Sync monitor, which will eliminate tearing and stuttering artefacts by syncing the refresh rate with your gaming frame rate, and arguably give you a more significant step up in visual quality than higher resolution. You can currently buy AOC's 24in G2460PG, which won an Approved award when we reviewed it in Issue 143, from www.scan.co.uk for £286 inc VAT.

It can run at a refresh rate of up to 144Hz, so you could take advantage of your GPU's spare processing power in the form of faster frame rates (and therefore a higher refresh rate), rather than higher resolution. **GPU**

WHEN'S THE NEXT MAG COMING OUT?
 Issue 152 of Custom PC will be on sale on Thursday, 10 March, with subscribers receiving it a few days beforehand.

MARCH 10

Send your feedback and correspondence to letters@custompcmag.org.uk



TRACY KING / SCEPTICAL ANALYSIS

STAR WARS IS ALL ABOUT ME

Tracy King asks whether Star Wars fans are really more likely to be narcissists, as reported in the press

Ba ba baaa Star Waars ba ba ba Staaaar Wars, to the tune of, duh, Star Wars. Everyone's now a bit Star Wars obsessive, partly because *The Force Awakens* is actually quite good, and partly because it isn't as bad as *Revenge of the Sith*. However, with a reinvigorated Star Wars culture comes a whole convoy of bandwagon journalism, including this absolute corker from *The Independent*: 'Star Wars fans and video game geeks "more likely to be narcissists", study finds.'

The University of Georgia, according to the article, found that people who take part in 'geeky events' are really up ourselves... themselves. It's a study of people who engage in various types of 'geeky' activities, from LARping and D&D to robotics, puppetry and video games. What's classified as 'geeky' in this case is what most people call 'hobbies,' and I would argue these hobbies are more a reflection of disposable income than anything else.

Indeed, the research was conducted at a sci-fi and fantasy convention in Georgia, so I could just as easily conclude that people who attend this convention are more likely to be narcissists, or that people who travel to Georgia are particularly self-involved.

Correlation doesn't imply causation, and it's hard to see what point the news coverage of this study is trying to make, unless the reporters are trying to say, 'Aha, we told you so, these people are awful, as per the stereotypes we all enjoy.'

I've been to the convention in question, Dragon Con, and I can confirm that some of the people there really are awful, and the vast majority are perfectly lovely. That's true of absolutely any large gathering of people. I've been to football matches and

music festivals and, yep, it's almost guaranteed that some people will be awful, but most people will be fine.

The study itself, published in the journal *PLOS ONE*, states that 'geek engagement is found to be associated with elevated grandiose narcissism, extraversion, openness to experience, depression, and subjective well-being across multiple samples'.

It's interesting. It's also flawed, because it's context-specific. The attitudes logged by the researchers at the convention may not be present when the subject is at home, work, school or anywhere other than Dragon Con. Maybe being at a convention makes you feel super-confident and awesome.

Or maybe these sorts of events are the only places that people into furry culture or *Rocky Horror* (two of the categories from the study) can feel extraverted and open. It would hardly be surprising, given that when a newspaper is presented with narcissism, extraversion, openness to experience, depression, and well-being, it chooses to go with just one of those options for the headline.

The narcissism at the convention was measured using the Narcissistic Personality Inventory. You can have a go online at <http://personality-testing.info/tests/NPI> – it's fun and slightly silly. One of the questions is, 'I prefer to blend with the crowd OR I prefer to be the centre of attention.' Most of you will immediately recognise that someone who prefers to blend in with the crowd at home may also well love being the centre of attention at a Doctor Who meetup, and thus the results would be skewed.

But what about Star Wars, as per the headline? Given that it's the biggest film franchise in history, I guess we're all narcissists. Let me go and check my test score. Yep, I'm the chosen one. **GPG**

What's classified as 'geeky' is what most people call 'hobbies'

Gamer and science enthusiast Tracy King dissects the evidence and statistics behind popular media stories surrounding tech and gaming [@tkingdoll](#)

Incoming

We take a look at the latest newly announced products

EKWB recalls Predator coolers

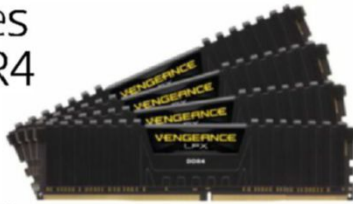
EKWB has issued a product recall of its acclaimed Predator all-in-one liquid-cooling systems 'due to potential risk of leakage of liquid from the unit'. According to the firm, the problem concerns faulty O-rings in the CPU waterblock, which came from a batch received by the company in November.

The company has since released a revision of the cooler, called Revision 1.1, which fixes the issue, but if you bought a Predator cooler before this revision, EKWB advises you to stop using it and contact the company to get a replacement or refund. You can see the company's full statement on the issue at <http://tinyurl.com/PredatorRecall>



Corsair unleashes high-speed DDR4

Corsair has just announced a load of super-fast, high-capacity Vengeance LPX DDR4 memory kits, with speeds of up to 3600MHz. The 3600MHz RAM comes in a 32GB (4 x 8GB) quad-channel kit, and the company has also introduced a 3000MHz 128GB (4 x 16GB) kit and a 3333MHz 64 GB (4 x 16GB) kit in the same line-up. All the new modules support XMP 2 and run at 1.35V.



AMD slashes Nano price

AMD has knocked down the price of its Radeon R9 Nano cards, which can now be bought for £350 inc VAT from www.overclockers.co.uk. Thanks to its use of high-bandwidth memory (HBM), which is integrated into the GPU package, AMD's Nano GPUs don't need large PCBs to accommodate GDDR5 memory chips, so Nano cards have a width of just 154mm.



NZXT embraces curves

Case manufacturer NZXT has taken a step beyond the straight lines in standard case design, announcing a shapely new mini-ITX chassis called the Manta. The company proudly claims that the Manta is the 'world's first case equipped with curved, structurally reinforced steel panels' and even says it can house three water-cooling radiators simultaneously, with room for 280mm designs in the front and a 120mm radiator at the back.

The case will also be equipped with NZXT's usual PSU shroud for a tidy build, as well as integrated fan control. The Manta will be priced at £120 inc VAT, with availability expected in February. We'll be taking a look at our first review sample in Issue 152.

Nvidia fights integrated graphics

In a bid to combat Intel and AMD's increasingly capable integrated graphics systems, Nvidia has launched a cut-price GPU called the GeForce GT 710. The chip has 192 stream processors and a 954MHz base clock, and cards will include 1GB or 2GB of DDR3 memory attached to a narrow 64-bit interface.

As such, the GT 710 is unlikely to be capable of running many games at decent settings, even at 1080p, though Nvidia claims its gaming performance is up to 80 per cent quicker than that of some IGPs. Many GT 710 cards have already been announced, including several passively cooled and low-profile cards. Prices currently start at £30 inc VAT from www.scan.co.uk for a 1GB passively cooled EVGA GT 710 card (pictured).



Reviews

Our in-depth analysis of the latest PC hardware



Reviewed this month

Asus ROG GX700 preview p17 / Intel Core i3-6100 p18 / Asus Maximus VIII Formula p20 /
Corsair H5 SF p24 / In Win Chopin p26 / QPAD DX-20 p28 / Custom kit p30

PREVIEW

Asus ROG GX700

Asus' new gaming laptop has a water-cooling module and a desktop-class GTX 980

The Asus GX700 is, technically, a new Republic of Gamers laptop. It's also absolutely bananas. It's the first laptop we've seen to come with its own water-cooling module, the Hydro Overclocking System, which is a mighty lump of mesh and metal that connects to the laptop with a row of self-sealing valves and a heavy, reassuring lever.

On the inside is a pair of radiators and fans that chill the CPU and GPU. They vent heat backwards and allow the GX700 to run its high-end hardware at proper desktop speeds and beyond.

The GX700 and the cooling module are huge and imposing. In fact, the machine includes its own wheeled carrying case.

It's unprecedented cooling hardware for a laptop headed for the production line, but it's needed to cool the top-end hardware inside. Asus has crammed the 8GB variant of the GTX 980 inside the GX700 – that's the desktop chip, not the mobile GTX 980M – alongside a Core i7-6820HK. The Hydro Overclocking System isn't just designed to chill the key components either, but also to eke out more performance from the silicon.

Basically, the Hydro unit enables Asus to run the GX700's major components at desktop speeds – the Core i7-6820HK can exploit its full Turbo Boost speed of 3.6GHz without fear of overheating, while the GPU happily runs at 1266MHz – a higher frequency than many GTX 980 desktop cards.

That's enough to ensure that the most demanding games run without a hitch, even with games running at their highest settings, and the 17.3in 1080p display even supports Nvidia's G-Sync tech to eliminate tearing and

stuttering artefacts in games. The specs are good elsewhere too, with two 512GB NVMe SSDs in RAID 0 configuration, and 16GB of DDR4 memory.

It's possible to go beyond the cooling dock's automatic overclocking, too. The Asus Gaming Center app can be used to tweak the components for a little extra power. If you're doing so, our sample's CPU topped out at 4.1GHz, while the GPU ran at up to 1.4GHz.

The GX700 continues to impress when it's detached from the Hydro Overclocking System, and the components are clocked down. The laptop itself is surprisingly slim and has no issues when it comes to build quality. It looks the part too – the system is made from a mix of gunmetal aluminium and matt black plastic, with red accents to the logos and keyboard.

It's no slouch in laptop mode either. When running on the mains and on battery power, our sample's GPU frequency still peaked at 1228MHz, and the CPU zipped along at 2.7GHz. They're good speeds, but they're also subject to change – Asus says the retail model may operate at different clock speeds.

We didn't encounter frame rate issues on our pre-production sample. Games looked butter-smooth with G-Sync enabled, and the GX700 played *Crysis 3*, *Fallout 4* and *The Witcher 3* at each game's top settings at the screen's native resolution without breaking a sweat. It also waltzed through PCMark and 3DMark tests with noticeable improvements when the cooling dock was used.

It was quiet too; the low rumble is far more subtle than that of many other gaming laptops.



We have no initial quibbles about this machine's sheer power, but a couple of issues appeared elsewhere. Ergonomically, our GX700 sample's touchpad buttons have a spongy action, and the keyboard's keys aren't particularly snappy either. We encountered some software gremlins too. Our early sample served up far too many warning messages about clock speeds changing, and sometimes it would reboot on its own. The cursor would also occasionally freeze.

Of course, this is all subject to change, because our sample is a pre-production model, and Asus has assured us that the GX700 is close to being finished, with tweaks to firmware, the BIOS and the storage capacities required before the production lines whirr into action. Oh, and the price? Asus estimates that this luxurious machine will cost a cool £3,500 inc VAT when it arrives in March. Get saving.

MIKE JENNINGS



LGA1151 CPU

Intel Core i3-6100 / **£93** inc VATSUPPLIER www.scan.co.uk / MODEL NUMBER BX80662I36100

Apart from the odd surprise such as the Haswell-based, multiplier-unlocked Pentium G3258, Intel's CPU offerings have been consistent in terms of overclocking abilities for a number of years. We usually get two K-series models per quad-core generation that are multiplier-unlocked – a Core i5 and Core i7, with a raft of non-K-series CPUs ranging from Core i7s all the way down to Pentiums. The Core i3-6100, then, appears to be a fairly run-of-the-mill offering for a £100 Intel CPU, except it now has one advantage that Intel is desperately trying to keep quiet – base clock overclocking.

Late last year, it was revealed that a number of motherboard manufacturers had found a way to allow base clocks that were much higher than previous maximums, partly due to the fact that Skylake's architecture allows for it, but also thanks to a few tricks from the motherboard manufacturers themselves. In short, base clocks in excess of 120MHz have now been achieved quite easily following BIOS updates, which means that CPUs such as the Core i3-6100 no longer languish at 3.7GHz, but can be overclocked to nearer 4.5GHz.

This is a huge deal for several reasons. The Core i3-6100 might only be a dual-core CPU, but it

supports Hyper-Threading, so it can execute four threads simultaneously, compared to the Pentium G3258's two, giving it an advantage in multi-threaded software.

Also, you can enable base clock overclocking on a budget Z170 board, so it's possible to build a fairly potent system and get plenty of change from £200 when you buy the CPU and motherboard.

However, there are a few catches. For a start, overclocking the base clock in this way disables the on-board GPU as well as all of the CPU's power-saving functions of the CPU. In

fact, the CPU is also forced to run at full speed all the time, which will lead to extra power consumption. For most enthusiasts, though, losing the on-board GPU isn't likely to be an issue, and the Skylake architecture is already very power-efficient, so the power consumption isn't likely to increase by a significant amount anyway.

Of course, Intel may well patch this bug in future revisions of its CPUs or force manufacturers to do it themselves via a BIOS update. However, buying the kit now means you're effectively immune to any subsequent patching.

With all that out the way, though, what's the Core i3-6100 like as a CPU on its own? It has a maximum stock frequency of 3.7GHz, which is 500MHz higher than the more power-frugal Core i3-6100T we used in our recent HTPC feature (see Issue 149, p88) but, more crucially, it has a much



higher multiplier (37x on the 6100 compared to 32x on the 6100T). As such, the 6100 is better suited to base clock overclocking, especially when budget Z170 boards may not be able to run the base clock much quicker than 120MHz.

Both CPUs have 3MB of L3 cache and lack Turbo Boost, plus they each use Intel HD Graphics 530. Again, to get its lower TDP of 35W compared to the Core i3-6100, the Core i3-6100T has a reduced GPU frequency too – 950MHz compared to 1.05GHz, although this will only matter if you're not using a discrete GPU. As with all Skylake CPUs, the Core i3-6100 is also fabricated using a 14nm manufacturing process.

There are also several other Core i3 Skylake CPUs with slightly higher multipliers; the Core i3-6300 and Core i3-6320 are clocked at 3.8GHz and 3.9GHz respectively, but cost £116 and £126 too. As such, if you're on a very tight budget, the £93 Core i3-6100 is where you'll find the sweet spot in terms of bang per buck.

Performance

At stock speed, the Core i3-6100 made short work of AMD's similarly priced A10-7870K APU and even gave the 6-core £170 AMD FX-8370E a run for its money in most of the media benchmarks, although the APU obviously has the benefit of a proper GPU. Only thanks to a monster score in the video encoding test was the AMD FX-8370E able to beat the i3-6100. The AMD A10-7870K and Pentium G3258 were far inferior, though, in every single test.

We then overclocked the Core i3-6100 using a new BIOS for our ASRock Z170 Extreme4 test motherboard, but these BIOS updates are freely available for most current Z170 boards. We hit 4.4GHz using a base clock of 119MHz and a 1.375V vcore, which was enough to pummel the A10-7870K and Pentium G3258 again, despite them also being overclocked. However, despite the inclusion of Hyper-Threading, it still wasn't enough to get close to any of the quad-core or 6-core CPUs on test in the multi-threaded video encoding test. When overclocked, the 6100 managed to surpass the FX-8370E's stock speed system score, but only just.

Amazingly, even when overclocked, the Core i3-6100 test system only drew 81W under load in Prime95. While we used a different GPU and motherboard when we reviewed the FX-8370E, the difference in power consumption as a result would be minimal. The latter's power consumption of 284W, then, is a stark reminder of the inefficiency of AMD's

We hit 4.4GHz
using a base clock
of 119MHz and a
1.375V vcore

/SPECIFICATIONS

Frequency 3.7GHz

Core Skylake

Packaging LGA1151

Manufacturing process

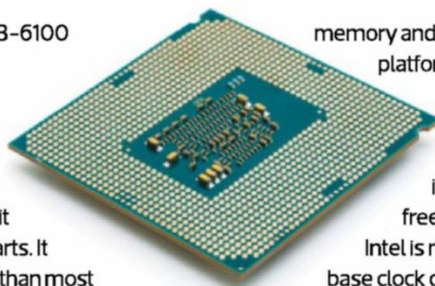
14nm

Number of cores 2 x
physical (4 threads)Cache L1: 4x 32KB, L2 2 x
256KB, L3 3MB (shared)Memory controller Dual-
channel DDR3L, DDR4, up
to 2133MHzFeatures SSE, SSE2, SSE3,
SSSE3, SSE4, SSE4.2,
AES, AVX, AVX2, EM64T,
F16C, Quick Sync Video

current CPUs, especially as the Core i3-6100 bettered it overall once overclocked.

Conclusion

Whether or not you'll be overclocking it, the Core i3-6100 offers compelling reasons to choose it over both its Intel and AMD counterparts. It has much lower power consumption than most similar AMD CPUs and APUs, and runs rings around most of them in many of our benchmarks. The only reason to consider an AMD APU now is for its GPU performance. The case for opting for a cheap Skylake system is fairly persuasive if you're on a budget though – you wouldn't save much by taking the Haswell route as an alternative, as the



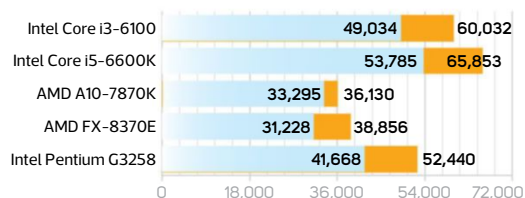
memory and motherboard prices between the two platforms are now roughly aligned.

The main reason we're most excited about the Core i3-6100 is the ability, for the moment at least, to overclock it. Netting an extra 700–800MHz for free is a huge deal, although we suspect Intel is more concerned about the impact of base clock overclocking on its non-K-series Core i5 and i7 CPUs than its Core i3 chips. Even so, if you're looking to build a super-budget system and plan on overclocking it, pairing a Core i3-6100 with a cheap BIOS-updated Z170 motherboard that supports base clock overclocking is currently your best option.

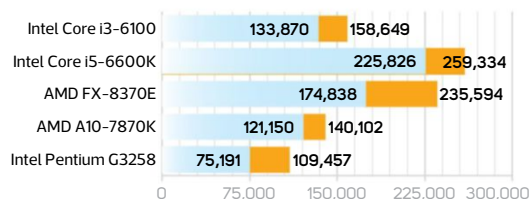
ANTONY LEATHER

CUSTOM PC REALBENCH 2015

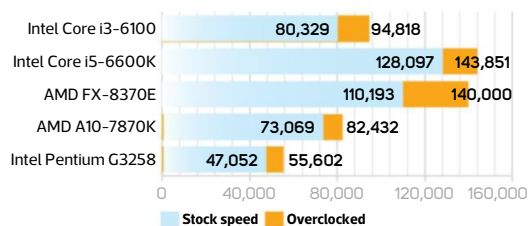
GIMP IMAGE EDITING



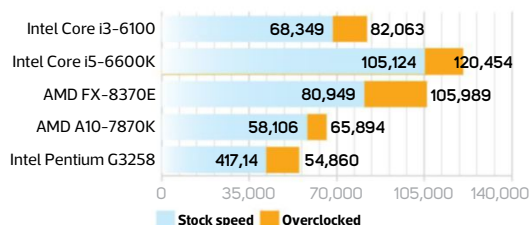
HANDBRAKE H.264 VIDEO ENCODING



HEAVY MULTI-TASKING

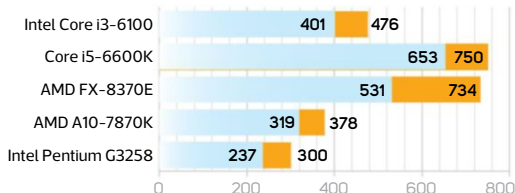


SYSTEM SCORE



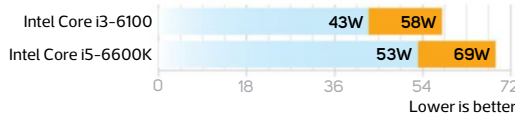
CINEBENCH R15

64-bit CPU Test

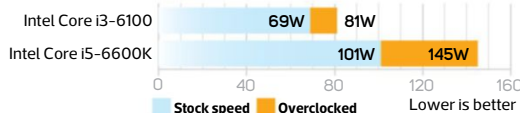


TOTAL SYSTEM POWER CONSUMPTION

Idle

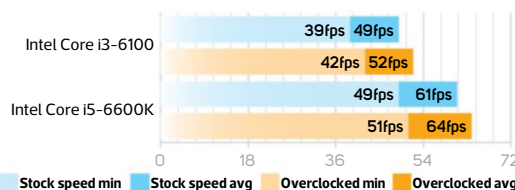


Load



TOTAL WAR: ATTILA

Quality Settings, 1,920 x 1,080, 0x AA



SPEED
36/50
FEATURES
13/15
VALUE
34/35

OVERALL SCORE
83%

VERDICT

A good CPU as standard, but the fact you can currently overclock it makes it a bargain that's ideal for building a budget gaming rig.

/TEST KIT

ASRock Z170 Extreme4 motherboard, 16GB Corsair Vengeance LPX 2666MHz DDR4 RAM, 256GB OCZ Arc100 SSD, Corsair HX860i PSU, Windows 10 Home 64-bit

ATX MOTHERBOARD

Asus Maximus VIII Formula / £275 inc VAT

SUPPLIER www.overclockers.co.uk

We have high expectations for Asus' Maximus VIII Formula, given its predecessors' prowess, and it looks like we won't be disappointed. The Maximus VIII Hero was one of the first motherboards to introduce customisable lighting, with Gigabyte playing with the idea too. However, the Formula takes lighting to a whole new level. Asus has removed all other colours from the PCB, making it look quite un-ROG-like, with just a few hints of colour around the heatsinks, plus a red LED POST code display. However, this setup enables the comprehensive RGB lighting system to make a big impact, and it's configurable in a desktop program.

The lighting comes from several sets of RGB LEDs, which are hidden under the large plastic shroud that covers most of the PCB. These LEDs illuminate the ROG logo on the PCH heatsink cover, the Formula text and the strips above the rear I/O shield. As the rest of the motherboard is black or silver, this system means you can effectively colour-match the board to your case and hardware, unlike the Hero, which had splatterings of red logos and only one RGB LED.

The Formula is fully kitted-out in other areas too, as you would expect with its astronomical price tag. Asus has worked in partnership with EKWB – maker of the awesome Predator all-in-one expandable liquid cooler – to create a VRM waterblock that also works as a standard heatsink. However, the waterblock/heatsink unit is essentially a single piece of metal with a copper insert that acts as a waterblock, cooling the entire heatsink. When it was plumbed into our loop, we found it shaved at least 5°C off the software-reported temperature of the VRMs compared with air cooling. As it has standard G1/4in ports, you can use practically any fittings too, although the RGB lighting system will make it hard for third parties to make full-cover waterblocks for the Formula.

There's a wealth of overclocking and testing tools included as well, such as illuminated power and reset buttons, and a clear-CMOS button on the rear I/O panel. There are also three 2-pin thermal sensor headers, which are accompanied by four case fan headers, two CPU fan headers and another header for powering 3 or 4-pin all-in-one liquid coolers.

While previous ROG boards we've reviewed have sported either M.2 or U.2 ports, the Formula has both, with the former located underneath a removable fascia in the shroud and supporting up to 110mm SSDs. As well as the usual six SATA 6Gbps ports you get from the Z170 chipset, there's an additional two via an ASMedia controller. However, rather than using an ASMedia USB 3.1

controller, Asus has opted for Intel's Alpine Ridge controller. There's no Thunderbolt support, but you get both USB 3.1 Type-A and Type-C ports.

At this price, there's obvious competition from X99 motherboards, especially as LGA2011 CPUs offer more PCI-E lanes for multi-GPU setups. There's no PLX chip on the Formula either, so it offers the usual dual 8x modes in 2-way multi-GPU setups, while the third slot is limited to 4x mode. There's plenty of other expansion room, though, with three 1x slots, one of which is located above the primary 16x slot, so you should always be able to access it.

While it lacks dual LAN ports, the single Intel Gigabit Ethernet port is enough for most people, plus the Formula also includes 802.11ac dual-band Wi-Fi, with a desktop antenna included in the box. As you'd expect, the on-board audio has been beefed up too, with the Formula sporting a Realtek-based SupremeFX 2015 audio codec with electronic shielding, Nichicon capacitors and an ESS ES9023P DAC.

The EFI and software bundle sport all the usual additional features we've come to expect from modern ROG boards as well, such as Keybot II, which enables any keyboard to record and execute macros and Windows shortcuts. Meanwhile, RAMCache works by using your system RAM as a super-fast cache drive to decrease load times, plus there's a handy SSD secure erase command built into the EFI.

Performance

The Formula's RealBench score of 135,385 is one of the faster results we've seen at stock speed, with an especially lofty score of 62,295 in the image editing test, although both the Maximus VIII Ranger and MSI Z170A Xpower Gaming



/SPECIFICATIONS

Chipset Intel Z170

CPU socket Intel LGA1151

Memory support 4 slots: max 64GB DDR3 (up to 3733MHz)

Expansion slots Three 16x PCI-E 3, three 1x PCI-E 3

Sound SupremeFX 2015 Realtek ALC1150

Networking Intel Gigabit LAN, 802.11ac Wi-Fi

Overclocking Base clock 40–650MHz, CPU multiplier 8–83x; max voltages, CPU 1.7V, RAM 2V

Ports 6 x SATA 6Gbps (Z170), 2 x SATA 6Gbps (ASMedia) 1x M.2, 1x U.2, 6 x USB 3, 1x USB 3.1 Type-A, 1x USB 3.1 Type-C, 4 x USB 2, 1x LAN, 8-channel audio, line in, mic, 1x HDMI 1.4, 1x DisplayPort

Dimensions (mm) 305 x 244



- 1** Several sets of RGB LEDs are hidden under the large plastic shroud
- 2** The VRM water-block was designed in conjunction with EKWB
- 3** The shielded SupremeFX 2015 audio system has an ESS ES9023P DAC

managed to beat its performance slightly overall. There was nothing nasty to report in our game test either, where the Formula matched the best results we've seen. Meanwhile, the Formula's power consumption was better than average under load at 131W.

We then managed to hit our joint maximum frequency of 4.9GHz using our Core i7-6700K, which required a hefty 1.41V vcore. Getting there was easy, though, thanks to Asus' excellent EFI. This result was enough to post a blistering RealBench score of 152,858, although the total system power consumption hit 207W with the CPU under full load.

Audio performance was excellent too, with noise and dynamic range figures of -104.6dBA and 104.6dBA respectively – on a par with the best we've seen, while the M.2 port was more than capable of dealing with a Samsung 950 Pro, dishing out read and write speeds of 2,200MB/sec and 958MB/sec respectively.

Conclusion

The Formula is undoubtedly one of the most expensive Z170 motherboards around, so if you have a limited budget, you can get a considerably cheaper board, such as Asus Maximus VIII Ranger, which will still offer similar performance. The Formula is for water-cooling enthusiasts and modders that want some colour coordination, but

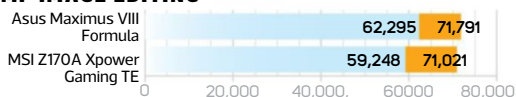


perhaps don't want the hassle of spraying their motherboard. Indeed, a VRM waterblock and RGB lighting kit would only set you back around £60 on their own, and the Formula's carefully coordinated out-of-the-box package makes for a hassle-free route. It might be ludicrously expensive, but if you don't need the grunt of an X99 setup and would benefit from the integrated water cooling and RGB lighting, the Maximus VIII Formula as desirable and feature-packed as motherboards come.

ANTONY LEATHER

CUSTOM PC REALBENCH 2015

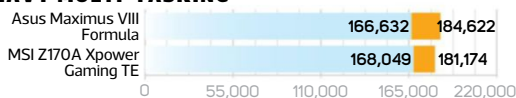
GIMP IMAGE EDITING



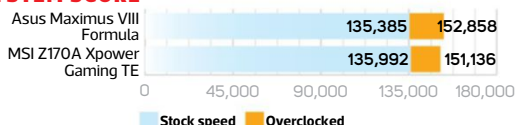
HANDBRAKE H.264 VIDEO ENCODING



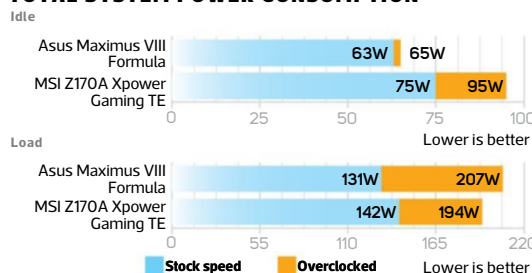
HEAVY MULTI-TASKING



SYSTEM SCORE



TOTAL SYSTEM POWER CONSUMPTION



TOTAL WAR: ATTILA

1,920 x 1,080, 0xAA, Quality setting



SPEED
38/40
VALUE
22/30

FEATURES
28/30

OVERALL SCORE
88%

VERDICT

It has a huge price tag, but the latest ROG board is packed with features, and the RGB lighting and integrated water cooling make it great for enthusiasts.

/TEST KIT

4GHz Intel Core i7-6700K, 16GB Corsair Vengeance LPX 2666MHz DDR4 memory, 256GB OCZ Arc 100 SSD, Corsair HX860i PSU, Windows 10 Home 64-bit



Performance without compromise



Spectre Lite

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- ASUS® M5A97 R2.0
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- ASUS® Maximus VIII Hero
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- 2GB NVIDIA® GeForce® GTX 960
- 1TB Hard Drive
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CPU COOLER

Corsair H5 SF / £62 inc VAT

SUPPLIER www.scan.co.uk / MODEL NUMBER CW-9060023-WW

Small form factor hardware is very much at the forefront of Corsair's plans for 2016. For starters, the company is expected to release a 600W SFX PSU, which would point to Corsair possibly making more mini-ITX cases that accommodate small PSUs, such as its existing Bulldog. However, another part of Corsair's small form factor equation is the H5 SF – an all-in-one liquid cooler that's designed specifically for small form factor cases.

It's the first of its kind, and it was designed specifically with the Bulldog in mind, as most mini-ITX cases can support at least a basic 120mm all-in-one liquid cooler without too much trouble. Corsair's own Obsidian 250D, Fractal Design's Core 500 and larger cases such as the BitFenix Prodigy and Phanteks Evolv ITX can all house

single 120mm and even double 120mm-fan radiators quite easily. It's when you're using even smaller cases that the H5 SF comes into its own, especially ones that only have enough room for a reasonably sized low-profile cooler, but no easily accessible fan mounts for a radiator.

The cooler itself uses a blower design similar to those used on

reference graphics card coolers, except the fan is larger, its noise is rated at 36–42 dB(A), and it spins between 1,000–1,800rpm, dishing out up to 24 cubic feet per minute (CFM). Air is channelled through a series of vents to a tiny 40mm radiator at the end of the cooler, which sits above your case's rear I/O panel, with a small foam shroud to make a seal between them. The fan points downwards as standard, but you can also remove the entire blower section and flip it so that the fan is drawing air from above. However, Corsair recommends using it with the fan drawing air from below, as doing so will aid motherboard cooling.

The cooler's total dimensions make it a similar size to a mini-ITX motherboard, although its 200mm length makes it a little longer than a 170mm mini-ITX PCB. It's also mounted offset to one side to allow enough clearance for a 16x PCI-E slot to be used, so it overlaps the motherboard by around 20mm on the opposite side. It sits at 84mm tall once mounted, so it isn't as short as some low-profile coolers, which in turn means it's 1mm too tall to fit into SilverStone's RVZ01 and FTZ01 cases.

As the cooler's exhaust is at the rear, and the cooler itself can't be adjusted up or down, the H5 SF isn't able to work with all cases. You'll need a large vent or fan grille above or next to the rear I/O cutout, which isn't found on some cases.



However, Corsair's own Obsidian 250D, Carbide Air 240 and Graphite 380T all have fan grilles located above the I/O cutout, so they'll be fine with it.

As the H5 SF needs to be mounted to a motherboard, there are restrictions in this respect too. A mounting plate is included, but it's strictly limited to mini-ITX motherboards, as larger boards simply have the mounting holes in the wrong place. In addition, mini-ITX motherboards with VRM daughterboards, such as Asus' Maximus Impact series, and older mainstream models from Asus, won't fit – firstly because the H5 SF's mounting bracket doesn't quite fit around the VRM PCB, but also because the rear of the PCB is at risk of shorting on the bracket.

Also, the H5 SF comes with some long screws that pass through the cooler mount, then through the motherboard holes, so they can screw into the motherboard standoffs. However, these screws aren't long enough to also go through the VRM daughterboard heatsinks on boards such as the Impact. Likewise, the Impact and similar boards also include extra-long screws to reach through to the motherboard standoffs, but these screws aren't long enough to also support the H5 SF either.

While there's no sideways or vertical adjustment with the cooler, though, several other mini-ITX motherboards we tried worked perfectly, despite having different CPU socket positions. The coolant tubes are relatively flexible and the ports on the pump section rotate to enable you to fit the H5 SF without too much trouble. Three large standoffs fix to the mount and screw to the cooler, while the mount uses standard motherboard mounting holes, plus longer screws, so you can secure it to your case's standoffs.



/SPECIFICATIONS

Compatibility Intel: LGA115x, LGA1366; AMD: Socket AM3+, AM3, AM2+, AM2, FM2+, FM2, FM1

Cooler size (installed) (mm) 167 x 200 x 84 (W x D x H)

Fans 1 x blower fan

Stated noise 36–42dB(A)

You'll need a large vent or fan grille above or next to the rear I/O cutout



- 1** The blower fan dishes out up to 24 cubic feet of air per minute
- 2** Air is channelled through vents to a tiny 40mm radiator at the end
- 3** It's mounted offset to one side to allow enough clearance for a 16x PCI-E slot



Performance

The H5 SF is comparatively noisy, even at low PWM fan speeds, compared with the likes of the H80i GT, while a Noctua NH-L9i we also had to hand was virtually inaudible. We tested the H5 SF with a Core i7-2600K both at stock speed (as shown in the graphs), and we also ran some overclocked tests at 4.4GHz using a 1.3V vcore. As results will vary between cases, our main results were obtained on a test bench, but we also used a Corsair Obsidian 250D case for testing.

At stock speed in the open, the H5 SF knocked a significant 19°C off the delta T achieved by the Noctua, although the H80i GT was 11°C cooler still.

Inside an Obsidian 250D, the difference between the H5 SF and H80i GT was similar. However, the H5 SF increased its lead over the NH-L9i by a further 6°C, most likely due to the fact that it could exhaust the warm air directly out the case, whereas the Noctua cooler dumped it all back inside.

Once overclocked, we ditched the NH-L9i, as it has a TDP limit of 95W, but the H5 SF still managed a respectable delta

T of 55°C when cooling our overclocked CPU, keeping it in check. However, the H80i GT was again much more adept here, knocking a further 17°C off this result.

Conclusion

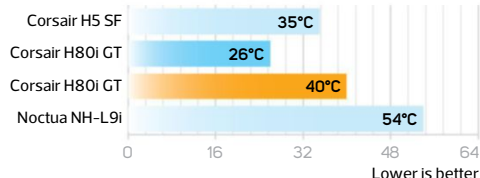
The Corsair H5 SF is a fascinating device, but it's in a bit of a no man's land. It's much noisier than nearly all the low-profile air coolers we've tested, especially the Noctua NH-L9i, but while it will outperform most of them in terms of cooling, the extra performance is only necessary for serious overclocks. Even then, the blower fan isn't ideal for a CPU cooler, and this is why graphics card reference coolers are usually the noisiest components in a desktop PC.

If your situation demands potent cooling and your case has a height limit of 84mm or less, it's worth considering the H5 SF if noise isn't too much of an issue. However, anyone with a nearby 120mm fan mount would be better served by a full-sized all-in-one liquid cooler, while the noise-conscious should look at the numerous air-cooled options that are significantly quieter.

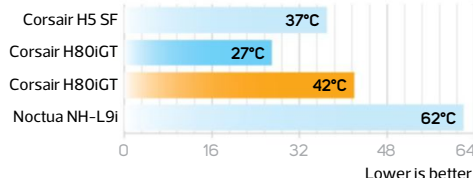
ANTONY LEATHER

CPU TEMPERATURE (DELTA T)

INTEL LGA1155 (test bench)



INTEL LGA1155 (Corsair Obsidian 250D)



Fixed fan speed High fan speed Low fan speed

LGA115x

COOLING
29/40

DESIGN
24/30

VALUE
24/30

OVERALL SCORE
77%

VERDICT

A valiant effort at creating a compact all-in-one liquid cooler, but the H5 SF will be too noisy for most people.

MINI-ITX CASE

In Win Chopin / £65 inc VAT

SUPPLIER www.overclockers.co.uk / MODEL NUMBER BQ696

Last month we looked at Fractal Design's excellent Core 500 (see Issue 150, p20), which is fairly typical of a cube mini-ITX case. You can fit relatively large graphics cards inside it, as well as a full-sized ATX PSU, 5.25in drives, several SSDs and fans, and even a modicum of water-cooling components too. However, you can make your system even smaller if you're prepared to chop a few items from your shopping list, and use a tiny case such as In Win's Chopin.

Our initial thoughts when we saw images of the case for the first time was that it was a relatively attractive mini-ITX case that could compete with the likes of In Win's own 901, or perhaps the Phanteks Evolv ITX. We were a little disappointed to read, then, that the Chopin lacked any

room for expansion slots – it was a motherboard-only case. However, when we looked at the dimensions, we were flabbergasted.

It measures only 84mm wide, just over 217mm deep and is only 244mm high. It's barely any bigger than a mini-ITX motherboard – in fact, a micro-ATX motherboard would entirely eclipse it if it were laid on top.

The case doesn't include a separate stand of its own but, when it's standing upright, one side is angled to act as a base, sitting on a pair of large rubber feet. The case is just as at home lying flat in desktop mode too, although it then has a much larger footprint.

It's extremely well made too, being constructed primarily from a single aluminium sheet that makes up the outer edge and steel innards. It also weighs a hefty 2.2kg – the Cooler Master Elite 130 only weighs 800g more yet is several times larger.

Our black sample looked gorgeous as well, with a subtle In Win logo on the front panel and two USB 3 ports, audio jacks and a power button located on one side – the case has all the usual front panel connectors for the headers on your motherboard.

Both side panels can slide off, revealing a very well thought-out interior. There clearly isn't a lot of room for CPU coolers; the extreme height limit of just 43mm meant we had to test the case in isolation, as it was too small for our usual mini-ITX test gear. Still, it gives you just enough room to install Noctua's excellent NH-L9i. Top-down coolers such as the NH-L9i will benefit from the large mesh side panel too, and while there are no exhaust fans or indeed fan mounts at all, the roof of the case sports another length of mesh for ventilation.

There's clearly no room in here for a standard PSU – not even an SFX-sized one, so In Win has included a tiny 150W model, which has a small fan that draws in air from the base and out the back of the PC.

It has just enough connectors, along with a bundled SATA power cable splitter, to power a motherboard and two 2.5in drives, courtesy of a pair of mounts in the rear half of the case. There's a lot of wasted room here though – you could easily fit a third drive here, but a 2.5in hard disk and an SSD for your OS is all most people will need these days anyway. Sadly there's no way to squeeze in a 3.5in hard disk though.

The Chopin is advertised in a range of colours, although the actual case only comes in silver and black – the extra colour comes from a selection of included coloured stickers that can be applied to small lips in front of the side panels, jazzing up the exterior a little, which is an attractive touch. We're massively impressed with the build quality too – not just on the outside. The steel inner frame provides a lot of the weight, and you get the feeling the Chopin would survive being carted around or dropped.

The only really notable omission is a dust filter. Admittedly, the PSU and side mesh vent have small holes, but they're still unlikely to prevent dust ingress. That's a shame – apart from the expected cramped interior, we have few other complaints about the case for the money.



/SPECIFICATIONS

Dimensions (mm) 84 x 217 x 244 (W x D x H)

Material Steel, aluminium

Available colours Black, silver

Front panel Power, 2 x USB 3, stereo, mic

Drive bays 2 x 2.5in

Form factor(s) Mini-ITX

Cooling None

CPU cooler clearance 41mm

Maximum graphics card length N/A

PSU 150W internal (included)

- 1 A single aluminium sheet makes up the outer edge of the case
- 2 There's a pair of 2.5in drive mounts in the rear half of the case
- 3 When it's standing upright, one side is angled to act as a base
- 4 The steel inner frame accounts for a lot of the case's weight

Meanwhile, the PSU is 80 Plus rated and has a 150W power limit. That isn't much, but it's enough to power most high-end CPUs, and it includes an 8-pin EPS 12V connector, a rather pointless 4-pin floppy connector and a single SATA power connector, which can be split in two using the included adaptor. Also included is a 3-pin, C5 Clover Leaf-style cable, as the PSU doesn't use a standard kettle lead. Installing hardware isn't too trying either, although routing cables from the main chamber to the SSDs can be a little fiddly.

Performance

Our main concern when testing small cases, as with mini PSUs, is noise. Every other PSU of this size we've reviewed has been noisy, sometimes intrusively so, but amazingly In Win has picked a corker here, as the PSU remained inaudible until our Core i7-2600K test CPU was under full load. Even then, it was actually much quieter than our fairly low-key Noctua NH-L9i cooler, which we'd knocked back to 7V in order to assess the Chopin's capabilities.

Overclocking in a case such as the Chopin is a big no-no, so we settled on a stock speed with our Core i7-2600K test CPU, which has a TDP of 95W – just within range of our Noctua cooler too. If the Chopin could handle a Sandy Bridge Core i7 chip, then it would also be fine with a quad-core Skylake or Haswell chip. Under full load in Prime95's smallfft test, the CPU delta T was 60°C, with a temperature reading of 83°C in CoreTemp. This temperature was read with an ambient temperature of 23°C, and the CPU fan was also limited to 7V, so the Chopin should have no problem dealing with CPU TDPs of 95W or less, even in summer.



Conclusion

We were pleasantly surprised by In Win's Chopin. Build quality is excellent throughout and the single-piece aluminium shell looks fantastic. It's obviously very limited in terms of space, and you'll need to carefully select your CPU cooler, but we built a complete PC in the Chopin in less than ten minutes with little fuss. The PSU is surprisingly capable and quiet too, even when dealing with our potent Core i7 CPU. In fact, it was quieter than the already discreet Noctua NH-L9i we used to test, making it great for a tiny, inconspicuous PC or HTPC, and an ideal partner for AMD's low-power APU's as well.

ANTONY LEATHER

CPU LOAD DELTA T TEMPERATURE



COOLING
23/30

FEATURES
16/20

DESIGN
27/30

VALUE
18/20

OVERALL SCORE
84%

VERDICT

The Chopin's excellent build quality, quiet operation and miniscule size make it ideal for building a small but powerful system, as long as you don't need a discrete graphics card.

/TEST KIT

3.4GHz Intel Core i7-2600K CPU, Noctua NH-L9i CPU cooler, ASRock B75M-ITX motherboard, 4GB of Crucial 2133MHz DDR3 memory, 256GB Crucial MX100 SSD

GAMING MOUSE

QPAD DX-20 / £70 inc VAT

SUPPLIER www.scan.co.uk

We reviewed QPAD's very first gaming mouse – the excellent SK – back in 2009 and since then the company has gone on to produce more great gaming mice, as well as keyboards and award-winning headsets. The DX-20, though, is a complete redesign and a comparatively expensive one too. It's still relatively long at 130mm, but it now lacks the five-finger grip support of its predecessors and sports an ambidextrous design, albeit with thumb buttons on the left side. It's narrower too, with no support for fingers other than your usual two finger buttons.

It's also much shallower than QPAD's other mice. It's inspired by Microsoft's legendary Intellimouse – and it's easy to see the resemblance – yet it also retains much of the prowess of QPAD's previous mice. Despite its smaller

volume, it still feels fantastic to use and it's long enough even for large-handed gamers, while small hands are still able to reach all the buttons, with the two main buttons requiring a fairly linear amount of actuation force most of the way back up the casing. This design will likely suit many grip types, plus the main buttons also use Omron switches.

The two side buttons are perfectly placed and only the very large or very small-handed would find any struggle to reach them. The button switches also feel fantastic in use, feeling more precise than those on Logitech's G402, for example. The same can be said for the scroll wheel too, which is supremely quiet whether you roll or press it.

There are twin DPI toggle switches for up and down shifting of the 3,500dpi optical Pixart 3320 sensor, which boasts zero acceleration. The rest of the specification might sound lacking compared with many modern gaming mice – a maximum tracking speed of 80in/sec and imaging speed of 3.6MP/sec are lower figures than even QPADs other mice, but such high figures are nominal for most gamers anyway. The DX-20 felt fantastic in games, with very positive and precise positioning, plus we found we became used to the design very quickly. At 97g, it also feels quite weighty for a small to medium-sized mouse, although it glides easily enough over most surfaces, especially fabric mouse mats.

/SPECIFICATIONS

Sensor 3,500dpi optical

Connection Wired, USB

Cable 2m, braided

Materials Plastic

Extras RGB lighting



Meanwhile, the included software is simple but inclusive of all the features you need to adjust the sensitivity at 50dpi intervals, albeit with no independent axis tuning, plus you can tweak the lift-off distance, USB polling rate and even do some macro recording. All seven buttons can be reprogrammed and you can control three RGB LEDs on the mouse too, including the logo, a base ring LED and scroll wheel DPI indicator.

Conclusion

The DX-20 doesn't have the extensive customisation of some other expensive gaming mice, but the software is easy to use and the mouse well made, well designed and very comfortable when gaming. It's a pleasure to use and very responsive. The only downer is the price, which is high for a mouse that lacks features such as a sniper button or independent X and Y axis sensitivity adjustment. If you have the money, and these features don't interest you, though, then the DX-20 is a cracking mouse that won't disappoint.

ANTONY LEATHER

DESIGN
38/40FEATURES
30/35VALUE
18/25OVERALL SCORE
86%

VERDICT

Well made, well designed and very comfortable to use. The DX-20 is a great addition to QPAD's peripheral stable, although it's not cheap.





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POWER BANK

Enerplex Jumpr Stack 9 / **£90** inc VAT

Weighing in at 235g and containing a capacious 9,400mAh battery, the Enerplex Jumpr Stack 9 is a serious power bank; it was able to charge our test Nexus 5X nearly three times over off a single charge. At £90, it's also seriously expensive, but it feels well made and it has good features, such as built-in, ruggedised micro-USB and Lightning connectors. There's also a standard USB port, and all three outputs can be used simultaneously.

Additionally, metal contacts on the top and bottom of the Stack 9 enable you to chain multiple units together into a single uber power bank. Given the capacity and expense of just one Stack 9, however, you'd have to be an off-grid oligarch to find this feature useful. It's a great product, but very expensive for what's basically still a battery.



SUPPLIER www.amazon.co.uk



BLUETOOTH EARPHONES

Jabra Sport Coach / **£100** inc VAT

Unlike most fitness hardware, the Sport Coach is designed for cross fitness enthusiasts, rather than runners and cyclists. The app with which the Coach interacts enables you to plan a gym workout program, and audio cues will then guide you through it via earphones. It's a smart idea, but the execution lacks finesse. You can't add custom exercises, for example, and the earphones have to be told that you've switched equipment via a button, rather than noticing via its on-board sensors. In terms of audio quality and comfort, though, the Coach is the best set of fitness buds we've tested. This alone makes the asking price almost seem worth it, but there's still a lingering feeling that you're paying above the odds because of the sub-par app.



SUPPLIER www.currys.co.uk

BOARD GAME

Codenames / **£12** inc VAT

Codenames is one of those rare games that are easy to pick up, but complex enough to be a favourite for a long time. Play takes place on a grid of random codename cards, with each name hiding a red spy, blue spy or civilian. The task for each team is to uncover all their spies first.

To aid the search, each side nominates a spymaster who knows what's under each codename and gives clues to guide their team's selections. A good spymaster finds links between the names, pushing their colleagues to uncover multiple spooks with one clue. Try to be too clever, however, and your teammates may misinterpret you and reveal an enemy spy. The joy (and tension) of the game lies in finding this balance, making it as much about reading your teammates as about having a large vocabulary. Brilliant stuff.



SUPPLIER www.gameslore.com





GAMES CONSOLE

ZX Spectrum Vega / £90 inc VAT

With retro styling designed to invoke the spirit of the famous 1980s machine, the Vega is an all-in-one ZX Spectrum emulator that plugs straight into your TV. A catalogue of 1,000 games is pre-installed, and while the majority are forgettable, some classics such as Knight Lore, Jetpac, Skool Daze and Sabre Wulf are present. A USB port is needed for power, but if your TV doesn't have one available, you'll need a spare smartphone charger handy, as there's no wall plug adaptor in the box.

That isn't the only sacrifice either. The controller feels cheap and there's little going on that you couldn't achieve with emulation software, plus many of the best early Spectrum games, such as Valhalla and The Hobbit, require a full keyboard, and thus aren't compatible with the Vega's minimal controls. There are other notable omissions from the supplied games list, presumably down to licensing issues. There's no Manic Miner, Jet Set Willy, Chuckie Egg, Dizzy, Starquake or HyperSports, for example, although you can thankfully add other games via an SD card with emulator files. The video output is composite rather than HDMI too, which sounds picky in a review of an 8-bit computer emulator, but along with the poor build quality, it emphasises the corner cutting. We expect more for just under £100.



SUPPLIER www.retro-computers.co.uk

POWER BANK

Cobra JumpPack /

£80 inc VAT

While most power banks are content with simply jump-starting a dead phone, the Cobra JumpPack aims a little higher. In a pinch, it can even jump-start a stricken car. Indeed, the Cobra is more of an emergency measure than an everyday power bank – there's a bright, built-in torch, which can flash rapidly to attract attention, for example, and it includes jump leads.

Given these leanings, it's forgivable that the JumpPack is less efficient than the Enerplex JumpStack 9 when charging our test phone, providing 40 per cent less charge, despite having only 20 per cent less rated capacity. The price of £80 inc VAT may seem expensive, then, especially for a device you'll hope to never use, but if you ever did find yourself sitting stationary at the side of the road, you'd be very glad it was there.



SUPPLIER www.argos.co.uk



AUDIO ACCESSORY

Startech Bluetooth Audio Receiver with NFC / £39 inc VAT

Bluetooth has become the de facto standard for simple audio streaming around the home, but what if you want to hook your old hi-fi into the loop? Well, that's exactly what the Startech Audio Receiver enables, and it does it very well too. It's unobtrusively small, sports analogue 3.5mm and digital optical outputs, and it can pair with a device via NFC, removing any need for fiddling about in any option menus.

Audio snobs may scoff that the Audio Receiver doesn't support flashy aptX audio compression, but in our testing, audio sounded clear and detailed – there wasn't a significant loss in quality when compared with a wired 3.5mm connection. Cheaper, non-NFC models are available on the market, but if you value NFC for easy communication between devices, the Audio Receiver builds a solid bridge between your hi-fi and Bluetooth gear for a good price.



SUPPLIER www.dabs.com



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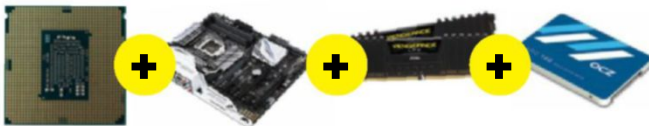
How we test

Thorough testing and research is the key to evaluating whether a product is worth buying, and deciding whether or not there's a better alternative

PROCESSORS

We judge CPUs on whether they offer sufficient speed for the price. Part of a CPU's speed score comes from how overclockable it is. Every type of CPU is tested in the same PC, so all results are directly comparable.

INTEL LGA1151



Intel LGA1151 CPU + Asus Z170 Deluxe (ASRock Z170 Extreme4 for Core i3 6100 test) + 16GB Corsair Vengeance LPX 2666MHz DDR4 + 240GB OCZ Arc 100

INTEL LGA2011-V3



Intel LGA2011-v3 CPU + Asus Rampage V Extreme + 16GB Corsair Vengeance LPX 2133MHz DDR4 + 512GB Crucial MX100

AMD FM2+



AMD FM2+ APU + MSI A88X-G45Gaming + 16GB Corsair Vengeance Pro 2133MHz DDR3 (GPU testing) + 8GB Corsair Vengeance Pro 1600MHz DDR3 (CPU testing) + 240GB Crucial M500

COMMON COMPONENTS



AMD Radeon R9 390X* + Windows 10 64-bit

TESTS: We use Custom PC RealBench 2015, Cinebench R11.5 and a variety of games. We also test the power draw of the test PC with the CPU installed. These tests reveal a broad range of performance characteristics, from image editing to gaming and video encoding to 3D rendering. We run all tests at stock speed and again when overclocked to its highest frequency.

*Please note: We test AMD FM2+ APUs using the on-board graphics, not the AMD Radeon R9 390X

GRAPHICS CARDS

Graphics cards are mainly evaluated on how fast they are for their price. However, we also consider the efficacy and quietness of the cooler. Every graphics card is tested in the same PC, so all results are directly comparable.



4.2GHz Intel Core i5-3570K

8GB Corsair Dominator 2400MHz DDR3

Asus Maximus V Extreme

Windows 10 64-bit

The graphics card we're reviewing

= SCORES

CUSTOM PC REALBENCH 2015

INTEL REFERENCE



Intel Core i7-4790K 16GB of Corsair 2400MHz DDR3 240GB OCZ 150 Asus Maximus Gene VII Nvidia GeForce GTX 780 3GB =100%

AMD REFERENCE



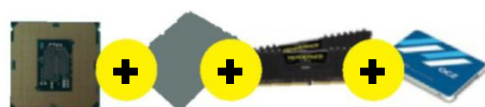
AMD A10-7850K 8GB of Corsair 2133MHz DDR3 256GB Plextor M5 Pro Asus A88X-Pro =100%

Our benchmark suite, co-developed with Asus, simulates how people really use PCs – a higher score is better. You can download them from www.asus.com/campaign/Realbench

MOTHERBOARDS

Motherboards are evaluated on everything from layout and features to overclockability and value for money. Every motherboard is tested with the same components, so all results are directly comparable.

INTEL LGA1151



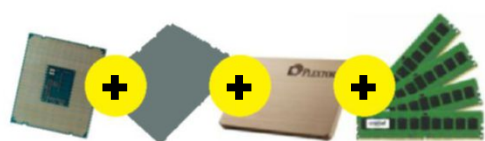
Intel Core i7-6700K Motherboard on test 16GB Corsair Vengeance LPX 2666MHz DDR4 240GB OCZ Arc 100

AMD FM2+



AMD A10-7870K Motherboard on test 16GB Corsair Vengeance Pro 2133MHz DDR3

INTEL LGA2011-V3



Intel Core i7-5960X Motherboard on test Plextor M6 256GB 32GB Crucial 2133MHz DDR4

COMMON COMPONENTS



AMD Radeon R9 390X* Windows 10 64-bit

TESTS: We use Custom PC RealBench 2015 and Total War: Attila, and also test the speeds of the board's SATA and M.2 ports. We try to overclock every motherboard we review by testing for a maximum QPI, base clock or HTT as well as overclocking the CPU to its maximum air-cooled level. We run our tests at stock speed and with the CPU overclocked.

*Please note: We test AMD FM2+ motherboards using the on-board graphics, not the AMD Radeon R9 390X

The Awards



EXTREME ULTRA

Some products are gloriously over the top. These items of excellent overclock earn our Extreme Ultra award.



PREMIUM GRADE

Premium Grade products are utterly desirable – we'd eat nothing but beans until we could afford them.



PROFESSIONAL

Products worthy of the Professional award make you and your business appear even more awesome.



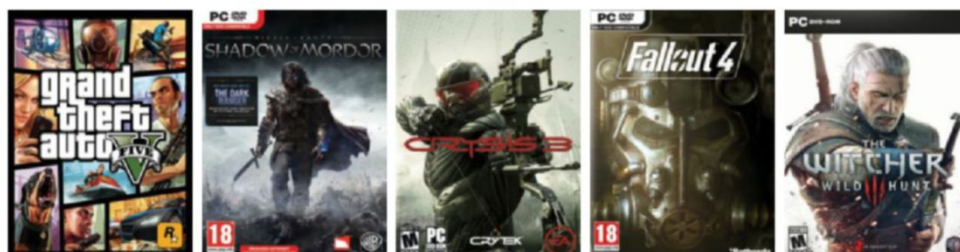
APPROVED

Approved products are those that do a great job for the money; they're the canny purchase for a great PC.



CUSTOM KIT

For those gadgets and gizmos that really impress us, or that we can't live without, there's the Custom Kit award.



TESTS: By using the fast PC detailed on the left, we can be sure that any limitations are due to the graphics card on test, rather than being CPU limited. We test GTA V, Shadow of Mordor, Crysis 3, Fallout 4 and The Witcher III: Wild Hunt at their maximum detail settings, in their highest DirectX mode, at several resolutions. High-end cards should be able to sustain playable frame rates at 2,560 x 1,440, while 1,920 x 1,080 is more important for mid-range cards; we also test at 3,840 x 2,160 for 4K monitors, and try to overclock every graphics card we test to assess the performance impact.



LABS TEST

4K goodness

With plummeting prices and massive improvements in image quality and gaming performance, there's never been a better time to buy a 4K monitor. We put ten 4K displays through their paces to find the best ones for your needs

A revolution in display technology has been unfolding recently, with improved panel techniques leading to superior image quality, higher resolutions, faster refresh rates and lower prices across the board. As a result, 4K screens are now not only cheaper but better than ever, and some even have support for AMD's FreeSync and Nvidia's G-Sync technologies, which lock a monitor's refresh rate to a video card's frame rate, eliminating tearing and stuttering artefacts.

In addition, some consumer displays now have 10-bit colour look-up tables, allowing for 1.07 billion on-screen colours, and the superior viewing angles of IPS panels are now used in a wide range of 4K displays, improving viewing angles and image quality, and with much better response times than previous IPS panels.

Even software support has improved. Windows 10 finally fixes most of the scaling issues that sometimes caused problems when running applications on a high-DPI display, all modern games support 4K resolution, and you can even run games at 4K using a sub-£500 graphics setup now.

If you're using an old 1080p monitor, perhaps based on older TN technology, an upgrade to a modern 4K display will improve quality all round. As such, this month's Labs focuses on 4K displays in several sizes, and with various technologies behind them, to find the best options. Not only that, but we've also taken a look at a curved ultra-wide monitor, and even a 5K screen, to see what the other options are like too.

ORESTIS BASTOUNIS

Contents

| | | | |
|--------------------|-----------------------------|--------------------------------|----------------------------------|
| How we test / p37 | Asus PB279Q / p40 | Iiyama ProLite X4071UHSU / p48 | 5K monitor |
| | Asus ROG Swift PG27AQ / p42 | Philips Brilliance | Dell UltraSharp UP2715K / p44 |
| 4K monitors | BenQ BL2420U / p43 | BDM3275UP / p50 | |
| Acer S277HK / p38 | Iiyama G-Master | Samsung UE32850R / p53 | Curved ultra-wide monitor |
| AOC U2879VF / p39 | GB2888UHSU / p46 | ViewSonic VP2780-4K / p54 | Philips BDM3490UC / p52 |

How we test

Since display tech has changed and improved recently, so too has the way we assess a monitor.

We still use a colorimeter to gauge image quality, but we've found there's far less variation between IPS panels than with monitors based on older TN technology.

For image quality testing, we use a Spyder 5 Elite colorimeter from Datacolor. This tool measures a few crucial aspects of a display to provide an objective assessment of its overall image quality. We run these tests twice, first on the screen after it's been reset to its default, out-of-the-box settings, and then again after it's been calibrated to 120 candela brightness.

The colorimeter first measures the colour gamut – the percentage of the sRGB and Adobe RGB colour palettes it covers. It measures the screen's brightness, gamma level, contrast ratio, black point and white point at different settings in the on-screen-display (OSD) from 0-100 per cent.

We also look at a screen's brightness uniformity, which measures different parts of the screen to show variation in brightness levels across the panel. The colorimeter provides a score that represents a screen's overall colour accuracy too, expressed as a factor of the total visible spectrum that a display can reproduce, known as delta E. It's generally assumed that most people can't notice the differences between screens with a delta E under 3, which until recently, was the level of accuracy offered by most consumer displays. However, thanks to the improved capabilities of 10-bit panels, most displays

offer a delta E result under 2 or even below 1, which is great.

There's a subjective aspect to image quality in addition to the test results as well. Brightness and contrast results alone can't describe how a monitor looks in front of the human eye, and there's great variation here when comparing TN and IPS panels. Viewed head on, a TN panel looks fine, but if you shift around, the colours can look decidedly odd. To judge this aspect as well as possible, we use each screen for a fair amount of time, in Windows and in games.

We've also looked at the physical design and features offered by each display. Some screens have built-in power adaptors, while others require external units that add to the mess of your computer desk. We also take the quality and flexibility of the stand into account – stands on different displays can

Our Datacolor Spyder 5 Elite colorimeter measures a few crucial aspects of a display to provide an objective assessment of its overall image quality

usually tilt backwards and forwards, rotate left and right on the spot, and swivel around for use in portrait mode. Not all displays allow such flexibility though.

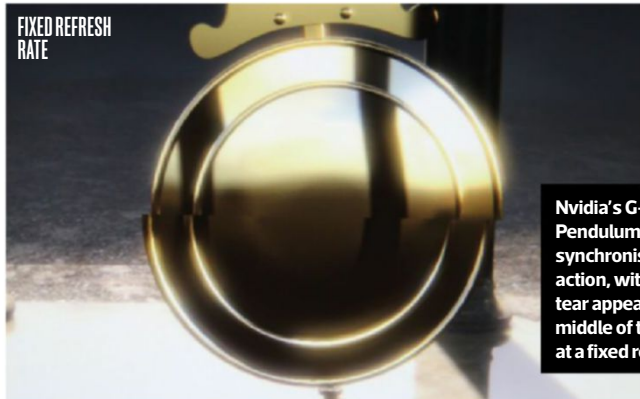
We also looked at the range of display inputs, subtracting a point if only a single HDMI or DisplayPort input was provided, while USB ports and built-in speakers along with a picture-in-picture (PIP) mode, for viewing multiple sources on screen at once, are factored into the Features score too.

There's considerable variation between the on-screen display (OSD) control systems of each display as well. Some provide considerable flexibility to finely tune the colours, with multiple white points and gamma levels, in addition to the usual gaming and movie presets, so the features score also accounts for the experience of navigating through the OSD. Some monitors have fiddly touch-sensitive buttons, or traditional physical buttons, but some now offer small navigation joysticks that make it really easy to quickly flick through screens of settings.

The scores have been derived from a combination of image quality, based on the colorimeter results and a subjective analysis, a value score, based on the price, screen size and panel technology, and a features score. Some of the screens on test also have adaptive-sync tech such as G-Sync or FreeSync, which add extra points to the features score, as they make a massive difference to gaming, eliminating tearing and stuttering.



FIXED REFRESH RATE



SYNCHRONISED REFRESH RATE



Nvidia's G-Sync Pendulum demo shows synchronisation tech in action, with a massive tear appearing in the middle of the pendulum at a fixed refresh rate

Acer S277HK / £419 inc VAT

SUPPLIER www.amazon.co.uk

Acer has dared to be rather different with its design of the S277HK, which adopts a unique L-shaped stand made from chunky solid metal, with the 27in screen supported on the right-hand side rather than the centre. It has a very thin bezel surrounding a metallic chassis at the front, with a look that's more in keeping with Macs than PCs. It's undoubtedly stylish, with a glossy white rear casing and all the ports indented in a small section in the middle.

There's a trade-off to positioning the stand on the right, though, because it's very rigid. Tilting the screen backwards and forwards is possible, but it can't be rotated, raised, lowered or swivelled into portrait mode. That's disappointing, given that the only two other displays on test that are limited in this way are the Iiyama X4071UHSU, which has the excuse of being a massive 40in beast, and the Philips Brilliance BDM3490UC, which has an ultra-wide design. There are also no USB ports; it relies on an external power supply and, topping off the limitations, it can't be used with a VESA mount either.

Meanwhile, video inputs are the standard affair. It has an HDMI 2 port, DisplayPort, mini DisplayPort and a dual-link DVI-D connector. That's enough for most people and, crucially, it gives you three inputs that can handle 4K at a 60Hz refresh rate.

The OSD controls aren't great either. A single large 'lip' on the right of the bezel's bottom edge lights up blue when the screen is powered on, and to its right are a set of physical buttons that navigate through the menus with a satisfying click. These buttons work, but the OSD menu leaves a lot to be desired. Navigating through screens is frustrating, as is the process of selecting settings, via five main icons that have no



Test results show 310cd/m² brightness, exceeding the quoted specification

explanatory text. It's certainly inferior when compared with the intuitive menu systems used by Philips and Asus.

However, you can't expect everything for £419 inc VAT, especially when you get a 27in IPS panel. The Acer costs £120 less than the Asus PB279Q and only £70 more than the Iiyama GB288UHSU, which is a TN screen with worse viewing angles. And, as you would expect from an IPS panel, the excellent image quality also makes up for the limited features.

The 10-bit IPS panel (Acer hasn't confirmed whether it's true 10-bit or 8-bit with dithering) has a quoted 4ms response time and, as with most 16:9 IPS panels, it has quoted 178-degree viewing angles, with brightness rated at 300cd/m². Generally, a 10-bit IPS panel should automatically mean a very good picture, and Acer doesn't disappoint with the S277HK. It looks bright and colourful, and the thin bezel accentuates the image.

Test results show 310cd/m² brightness, exceeding the quoted specification, with contrasts levels of 560:1. It only managed 77 per cent Adobe RGB coverage, while other IPS screens on test hover around the 80 per cent mark, but it's a difference that most people

won't notice. Meanwhile, colour accuracy results show a delta E of 0.87, a fantastic result that comes courtesy of the 10-bit panel. In terms of picture quality, the Acer S277HK absolutely nails it.

Conclusion

Despite its low price, the Acer S277HK offers picture quality that matches far more expensive competitors. There's no doubt that it's a bargain too, but bear in mind the lack of USB ports, stand flexibility and the clunky OSD. If none of these drawbacks matters to you, though, the S277HK is a great deal.

IMAGE 43/50 FEATURES 10/20 VALUE 27/30

VERDICT

Great image quality for the price, but it has an inflexible stand, a clunky OSD and it lacks features.

OVERALL SCORE
80%

/ SPECIFICATIONS

Resolution 3,840 x 2,160

Panel tech IPS

Inputs 1x DisplayPort 1.2, 1x Mini-DisplayPort, 1x HDMI 1.4, 1x DVI-D

USB None

Speakers Stereo speakers, 3.5mm in/out

Power supply External

OSD control Buttons



AOC U2879VF / £279 inc VAT

SUPPLIER www.scan.co.uk

With launch prices of several thousand pounds, 4K displays have earned a reputation for being hideously expensive, and you didn't even get a 60Hz refresh rate on some early 4K models. As the technology has become more mainstream, and production lines have matured, though, you can amazingly now pick up a 4K screen under for under £300 inc VAT.

That's exactly what AOC has managed to achieve with the U2879F. It's the most affordable 4K display we've ever seen, and the cheapest on test by around £100, behind both Iiyama's GB2888UHSU and BenQ's BL2420Z.

Amazingly, the AOC U2879F is also a 28in display, with a 10-bit panel. It uses TN technology, though, which has the benefit of quick response times, but has worse viewing angles than IPS screens. Like Iiyama's GB2888UHSU, it also offers support for AMD's FreeSync technology at up to 60Hz at 4K, and it's great to see this feature in a low-cost display, especially when the equivalent G-Sync displays for Nvidia users cost so much more money. There's a snag, though, which is that FreeSync only works between 40Hz and 60Hz, so you'll lose the benefits if your frame rate drops below 40fps, which is sadly very likely given the tough hardware requirements of 4K gaming.

Unfortunately, AOC has also cut a lot of corners to achieve the low price. First off, the glossy plastic materials used for the front and back feel very cheap. Then there's the lack of support for VESA mounting, built-in audio and any movement in the stand at all. Granted, not everyone will choose a display based on just these features, but the lack of flexibility in the stand is particularly irritating.



There's a good range of video inputs though. DisplayPort 1.2 and HDMI 2 are present for 60Hz 4K use, and there are DVI-D and VGA connectors for legacy connections as well. Meanwhile, the OSD uses physical buttons, with a general menu design that works well, using the traditional input method of left, right, up and down through the large on-screen menus.

There's a picture-in-picture (PIP) mode, five display presets, three gamma settings and three colour temperatures.

In testing, the AOC 2879VF competes well with other 10-bit displays that. The brightness of 318cd/m² is a fine result, as is the 600:1 contrast. Its gamma is off by 0.2, the sRGB result is 95 per cent rather than 100 per cent, and the Adobe RGB result of 75 per cent is slightly lower than other displays. However, its deviation of 8 per cent isn't too bad, and neither is the delta E colour accuracy of 1.23.

Unfortunately, there's a downside to this low-priced display that the results don't show. In use, the image is noticeably oversaturated, to the point where the image quality suffers greatly. Next to the other TN panel on test, Iiyama's GB2888UHSU, it just doesn't look as good, and of all the displays we tested this month, the AOC has the worst out-of-the-box subjective image quality.

Conclusion

The U2879VF might seem like a bargain, but it has many niggles, such as an oversaturated image, cheap materials, an inflexible stand and a lack of features. The same money will get a good 1080p or 2,560 x 1,440 display with superior build quality, image quality and more features. If you really want a 4K display, then you'll be better off spending a bit more cash to get a superior screen.

| IMAGE | FEATURES | VALUE |
|-------|----------|-------|
| 31/50 | 13/20 | 27/30 |

VERDICT

A great price, but its image is oversaturated, the stand is inflexible and it lacks features.

OVERALL SCORE
71%

SPECIFICATIONS

Resolution 3,840 x 2,160

Panel tech TN

Inputs D-Sub, DVI, HDMI 2, DisplayPort

USB 1 x USB 2 input, 2 x USB 2 outputs

Speakers None

Power supply External

OSD control Buttons

Extras AMD FreeSync support



Asus PB279Q / £540 inc VAT

SUPPLIER www.overclockers.co.uk

Unlike Asus' ROG Swift PG27AQ, which supports G-Sync (see p42), the PB279Q is aimed more at general use than gaming. It's a 27in IPS monitor with an effective 10-bit (8-bit with dithering) panel that supports a 5ms response time. There are some immediately noticeable differences in the design between the PG27AQ and the PB279Q. The latter's bezel is a lot thicker, and the stand has none of the red trim or shining LEDs. Clearly, someone at Asus thinks only gamers will care about bezel size. Instead of the useful joystick to control the OSD, you also get a rather mundane array of six buttons.

One major difference, of course, is the price. At £540 inc VAT, the PB279Q isn't the cheapest 27in 4K display on test, but it costs £176 less than the PG27AQ, and it's also cheaper than ViewSonic's VP2780-4K. The TN and VA panels are cheaper, naturally, but the only 27in IPS display that's cheaper is the Acer S277HK (see p38).

You get a lot of features for that money too. The OSD menus are well designed, and jam-packed with useful features. As on gaming displays, there's a crosshair mode for aim assistance, and there are plenty of preset colour and white point settings. It has more ports than any other display on test as well, including DisplayPort, mini-DisplayPort and four HDMI ports, although these connectors are all HDMI 1.4, so they're limited to 30Hz only at 4K resolution. There's also a picture-in-picture (PIP) mode that's very simple to set up, plenty of shortcut functions and even a few extra Asus features. Another couple of niceties include the internal power supply, which uses a standard kettle lead, and support for VESA mounting at the back.



The OSD menus are very well designed, and jam-packed with useful features

The feature list is missing a few bits and pieces though. There are no built-in USB ports and while the stand is good quality, and can swivel to portrait mode, rise up and down, and tilt backwards and forwards, oddly it can't rotate on the spot. It's not a major issue, though, and neither is the terrible audio from the 2W speakers, since many PC enthusiasts will be routing their PC audio through a half-decent speaker set or sound system anyway.

More importantly, though, the picture quality is superb. We recorded a maximum brightness of 329cd/m² and a contrast ratio of 600:1. That's in addition to 100 per cent sRGB coverage and 80 per cent Adobe RGB coverage, which is in line with what we'd expect from a 10-bit IPS panel.

The brightness uniformity across the panel is also very good, with an average deviation of just 8 per cent – one of the better results we recorded. Meanwhile, its uncalibrated colour accuracy comes to 1.29, which might appear higher than many of the other displays, but this result is still brilliant, when you consider that any result under 2 is generally enough to fool the human eye.

Conclusion

The PB279Q doesn't attempt anything clever, and its design is rather drab compared with alternative Asus displays. It doesn't pretend to be anything other than a good-quality 4K IPS display, and that's nothing to be ashamed of.

Combine the PB279Q's excellent image quality with a great menu system, a wide range of inputs and a mostly flexible stand, and you get a great monitor that's well worth considering for its price, if you're not interested in adaptive-sync tech.

IMAGE 44/50 FEATURES 13/20 VALUE 25/30

VERDICT

If you're not interested in giant screens or gaming features, the PB279Q is a great IPS monitor.

OVERALL SCORE
82%

SPECIFICATIONS

Screen size 27in

Resolution 3,840 x 2,160

Panel tech IPS

Inputs 1x DisplayPort, 1x mini-DisplayPort, 4x HDMI 1.4

USB None

Audio 2 x 2W speakers, 3.5mm in/out

Power supply Internal

OSD control Buttons

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Asus ROG Swift PG27AQ / £716 inc VAT



SUPPLIER www.scan.co.uk

We only covered the Asus PG27AQ a few months ago, where it immediately grabbed a well-deserved place on our Elite List. It's the first 4K display to offer G-Sync, Nvidia's adaptive-sync technology, with an IPS panel. G-Sync only works with Nvidia GPUs, of course, but it works really well, eliminating tearing and stuttering artefacts and, unlike some FreeSync displays, it still works at lower frame rates. Speaking of which, 4K displays currently only go up to 60Hz, unlike some 2,560 x 1,440 displays, which go up to 144Hz, as the DisplayPort 1.2 standard can't provide enough bandwidth for higher refresh rates at 4K resolution.

The PG27AQ is extremely well built. Asus has tarted up the typical boring display design and added some flair, with red trim, an angled design at the back and a red LED around the base that glows in use. The bezel is notably svelte, while the stand offers full tilt, height, swivel and rotate motion, with a well-built angular dark grey plastic used for the base.

The other notable aspect of the physical design is the use of a joystick to control the OSD, along with a triangular button on the right edge. The Philips BDM3490UC also deserves praise for this reason, and it's a great feature – touch-sensitive buttons can often be too sensitive, and physical buttons can be confusing when you have to figure out which one moves up in the menu system and which one moves across.

It also helps that the PG27AQ's menu system has a great layout and design. It pops up in the bottom right, with on-screen indicators to show each button's function, it flicks through each screen quickly and there are lots of settings to customise the visual appearance. There are four colour



temperatures and a number of preset modes, but no gamma controls. By squeezing G-Sync into a display, a few features have been cut as well, with no support for Nvidia's 3D Vision or ultra-low motion blur technologies, but neither is a deal breaker.

There's an on-screen crosshair and an FPS counter too, which works at up to 60fps due to the refresh rate being locked to the graphics card's frame rate. There's no picture-in-picture (PIP) mode, though, which is a missed trick, given that the PG27AQ has more than one input. G-Sync has previously been limited to just a single DisplayPort input, but Nvidia now supports a second HDMI input in the updated v2.0 circuit design, used on the PG27AQ. It's only an HDMI 1.4 input, and it can't handle an adaptive-sync signal, but it's potentially handy if you want to hook it up to a console or Blu-ray player.

The picture quality is also excellent, though our tests show it isn't the brightest screen. We measured 291cd/m², which is the lowest result of any of the IPS models. Its delta E colour accuracy is lower than we expected too, as is the average brightness deviation, which was worse than other screens. The gamma result was spot on at 2.2, though, and the sRGB coverage came to 100 per cent, with 80 per cent Adobe RGB coverage.

However, this is primarily a gaming display, and on the Windows desktop, the picture looked subjectively as vibrant and clear on

the PG27AQ as on most of the other IPS screens on test. It has great viewing angles, it looks very bright and colourful, and the contrast is good.

Conclusion

The one downside of the PG27AQ is its high price, which is mainly down to the support for G-Sync. If you want a gaming display to connect to an Nvidia GPU, though, the PG27AQ is about as good as it gets.

IMAGE 43/50 FEATURES 18/20 VALUE 23/30

VERDICT

If you're a gamer with an Nvidia GPU, and want a 4K IPS screen, this is as good as it gets.

OVERALL SCORE
83%



SPECIFICATIONS

Screen size 27in

Resolution 3,840 x 2,160

Panel tech IPS

Inputs DisplayPort 1.2, HDMI 1.4

USB 1 x USB 3 input, 2 x USB 3 outputs

Audio 2 x 2W speakers, 3.5mm in/out

Power supply External

OSD control Joystick

Extras Nvidia G-Sync support

BenQ BL2420U / £376 inc VAT

SUPPLIER www.novatech.co.uk



A 4K resolution may seem unnecessary for a small screen with just a 24in diagonal measurement, but the result is super-sharp pixel density once you set up scaling in Windows. It's a little like the effect of a Retina display on an iPhone or iPad, resulting in beautifully rendered curves, crisp text and better overall legibility.

The BL2420U is based on IPS technology, with an 8-bit panel. It's designed for professional graphics use rather than gaming, which is evident in the plain appearance, large bezel, especially at the lower edge of the screen, and the 7ms response time, which is slightly higher than most of the alternative IPS panels on test.

The specs are good though. The IPS panel offers 178-degree viewing angles, and there are HDMI 2, HDMI 1.4, DisplayPort and DVI-D inputs. The stand is flexible in every direction as well, with full tilt, pivot and height adjustment, plus on-the-spot rotation. It has VESA holes for use with a monitor arm too, plus a two-port USB 3 hub and an admittedly weak pair of 1W speakers.

BenQ's OSD system also gives Philips, Dell and even Asus a run for their money when it comes to layout and design. Navigation is very straightforward, and the pop-over icons that appear when you press a button are both clear and colourful. In the menus, there are lots of presets and settings you can tweak. A whopping count of 11 presets are included as well, with names such as sRGB, CAD, Animation and Presentation, with three colour temperatures, three white point settings and five gamma settings. Our only minor beefs with the menu system are a lack of a picture-in-picture (PIP) mode and the touch controls, which are little too sensitive, as on other displays.

The picture quality is outstanding, though. In our tests, the panel showed 6 per cent deviation in brightness uniformity, with a high degree of colour accuracy, showing 100 per cent sRGB and 80 per cent Adobe coverage. It also produced a great delta E result of 0.76. Meanwhile, the brightness measurement of 308cd/m² is reasonable, and the contrast ratio of 730:1 is the second highest of any IPS display on test.

The gamma result is also spot on the target 2.2 figure. As the



It's a little like the effect of using a Retina display on an Apple iPhone or iPad

smallest display on test, it also had the lowest power consumption, drawing just 31W from the mains at 100 per cent brightness. At the other end of the scale, Dell's UP2715K guzzled 75W.

That leaves the crucial subjective analysis of image quality, which is where the 2420U excels. Its picture looks better than that of some of the more expensive models, with a really crisp and colourful picture. It looks a little oversaturated in the red spectrum, but you have to look hard to see this effect. What's more, the effect of the tiny pixels makes the 2420U's image look very sharp.

Conclusion

With its 24in diagonal, the BenQ BL2420U is the cheapest IPS display on test, costing the same

amount of money as Iiyama's GB2888UHSU, which is a 27in TN display. The BL2420U is the superior monitor at this price though. The image quality is superb, and it offers a full set of good features. There are many reasons to choose a smaller screen over a massive one, such as a sharper picture, as well as saving desk space, and the BL2420U shows that good things can also come in small packages.

IMAGE 43/50 FEATURES 15/20 VALUE 25/30

VERDICT

Great image quality, super-sharp pixels and loads of features for a very reasonable price.

OVERALL SCORE

81%

SPECIFICATIONS

Screen size 24in

Resolution 3,840 x 2,160

Panel tech IPS

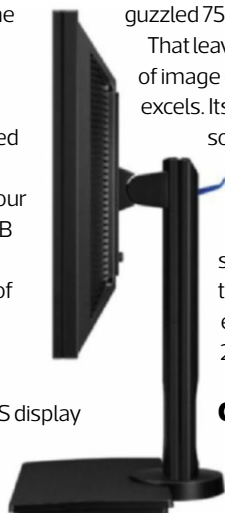
Inputs DisplayPort 1.2, HDMI 2, HDMI 1.4, DVI-D

USB 1 x USB 3 input, 2 x USB 3 outputs

Speakers 2 x 1W speakers, 3.5mm in/out

Power supply Internal

OSD control Touch



5K MONITOR

Dell UltraSharp UP2715K / £959 inc VAT

SUPPLIER www.scan.co.uk

Dell's 27in Dell UP2715K offers a compelling alternative to the 4K displays on test this month, with a higher resolution and even smaller pixels. The standard 4K resolution of 3,840 x 2,160 is exactly four times 1,920 x 1,080, and if you similarly multiply 2,560 x 1,440, you end up with the Dell's 5,120 x 2,880, or 5K, resolution.

There's a small problem though. Driving this number of pixels at 60Hz requires more bandwidth than a single DisplayPort 1.2 cable can handle, so you need to connect two cables to the UP2715K from your graphics card. The DisplayPort 1.3 standard will overcome this limitation, but no graphics card supports it yet. You can also use the Dell UP2715K as a 4K display with a single cable connected to the mini-DisplayPort input.

HDMI has been omitted completely. The UP2715K is specifically aimed at graphic designers and artists, so it's assumed you'll be using a high-end PC, not a PlayStation. That hasn't prevented Dell from going all out with the speakers, though, including two 16W cones from Harman Kardon, which sound notably better than the speakers on most displays.

The 8ms response time is another reason to disassociate the UP2715K from gaming, being slightly slower than other IPS 4K screens, which are down to 4ms or 5ms, while TN screens are even quicker.

It has a boxy, dark grey design, with a metal stand that supports the full range of pivot, tilt, rotate and height adjustments. The screen is also coated in glass, for a slightly reflective image. There are loads of USB 3 ports as well, and the OSD is controlled with physical buttons on the right edge.

With 10-bit colour processing and a 12-bit look-up table, the Dell's IPS panel is capable of great colour reproduction. It also carries a significantly higher price than many 4K screens, but the test results tell you why. The sRGB result of 100 per cent can now be managed by most good IPS monitors, but the Adobe RGB result of 99 per cent is particularly impressive, being



better than any of the gaming-focused 4K screens on test.

Likewise, the maximum brightness of 342cd/m², and the 7201 contrast ratio, are impressive figures, although the brightness distribution average of 5.95 per cent, while a good result, isn't the best result we recorded. Its uncalibrated delta E under 2 shows reasonable accuracy as well, and this result dropped to 1 after calibration. Also worthy of note is the great gamma result of exactly 2.2, with no deviation on either side.

The image really blows you away when you see it though. It sounds like hyperbole, but the amazing on-screen colours inject new life into content. Greens show up that you never noticed before and reds are incredibly bright. Combined with the very high resolution, the result is the best image quality we've seen.

On the downside, the 75.4W power consumption is very high, and Windows can still randomly switch to 100 per cent scaling sometimes, at which point text becomes unreadable on this 5K monitor. Gaming at this resolution is also even more demanding than at 4K, requiring a serious multi-GPU setup.

Conclusion

The Dell UP2715K is a cut above the rest, but at a price that will put off many people. For the same money, you could buy two 4K monitors, although neither would offer the fantastically rich colours and sharpness of the Dell. If sharpness and image quality are your top priorities, and you have the money, the UP2715K is an excellent monitor.

IMAGE 48/50 FEATURES 15/20 VALUE 18/30

VERDICT

It's pricey, but its image quality is second to none, with a sharp picture and great colour reproduction.

OVERALL SCORE
81%

/ SPECIFICATIONS

Screen size 27in

Resolution 5,120 x 2,880 (60Hz)

Panel tech IPS

Inputs 2 x DisplayPort, 1 x mini-DisplayPort

USB 1 x USB 3 input, 5 x USB 3 outputs

Speakers 2 x 16W Harman Kardon

PSU Internal

OSD control Physical buttons

Extras Card reader



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Iiyama G-Master GB2888UHSU / £358 inc VAT

SUPPLIER www.ebuyer.com

TN technology is traditionally much cheaper than IPS tech. TN panels are also known to be better for gaming due to lower response times, while early IPS screens had much higher response times, leading to noticeable ghosting. However, IPS has the key advantage of superior viewing angles, often with much better overall picture quality. And now, the advantages of TN screens are mitigated by cheaper IPS panels and much better response times. But TN technology is improving as well, often matching the contrast and brightness of IPS panels. Enter Iiyama's GB2888UHSU, a 28in 4K TN display that significantly undercuts the price of many similarly sized 4K IPS screens by some margin.

It also helps that the GB2888UHSU is a good all-round display. It has a stand with the full range of movement, rotate, swivel, pivot and height adjustment. It has a massive range of video inputs too, with three HDMI connectors (including an HDMI 2 socket), DisplayPort and a legacy VGA input. The design is rather plain, but functional, and it also comes with a two-port USB 3 hub and a pair of 3W speakers.

Unfortunately, the OSD control system doesn't measure up that well. It has small rounded buttons, which respond to a gentle touch rather than a hard press, and they're very sensitive. It takes a while to get used to the amount of pressure needed to flick through the menus, and you end up longing for a standard button system. The menus use the same system as the ViewSonic V2780-4K – you press 1 to go back, and 2 to go forwards or select. There are plenty of colour presets and options, including a picture-in-picture (PIP) mode, and it's easy to navigate once you get used to the control system.

The G-Master GB2888UHSU supports AMD's FreeSync tech as well, eliminating stuttering and tearing artefacts in games with an AMD GPU. However, the catch is that FreeSync only works between refresh rates (and hence frame rates) of 35Hz and 60Hz, which is better than the 40-60Hz range offered by some other FreeSync displays, but never dropping below 35fps is still a tough ask of most PC gaming hardware at 4K.

On to the big question – how does this TN panel compare with its IPS counterparts? The



Subjectively, the picture quality looks bright and colourful

picture is reasonably bright, at 290cd/m², and the 600:1 contrast ratio is good too. Meanwhile, the colour gamut hits 96 per cent sRGB coverage and 74 per cent Adobe RGB coverage, with a delta E of 1.87, which is slightly worse than other displays but still well under the optimal result of 2. Its gamma result of 1.9 is also off target by a wider margin than the other displays on test, which are all within 0.1 or 0.2. Subjectively, though, the GB2888UHSU picture quality looks bright and colourful, and it lacked the saturation issues of the other TN panel on test – AOC's U2879F. On the downside, it naturally lacks the strong viewing angles of IPS screens, which also offer superior colour accuracy.

Conclusion

With a price of just £358 inc VAT, the Iiyama G-Master GB2888UHSU offers good value for money for a 28in 4K display, but IPS screens are now falling in price too. The Acer S277HK (see p38), for example, costs just £62 more. There are also VA panels, such as

Iiyama's own X4071UHSU, which provide some strong competition in a similar price bracket. If you're on a tight budget, the Iiyama G-Master GB2888UHSU offers a solid feature set and a decent image, but if you can find the cash, we recommend spending a little more money on an IPS display instead.

IMAGE 38/50 FEATURES 16/20 VALUE 24/30

VERDICT

Great image quality for a TN panel, but it's now up against stiff competition from IPS panels.

OVERALL SCORE
78%

SPECIFICATIONS

Screen size 28in

Resolution 3,840 x 2,160

Panel tech TN

Inputs 1x DisplayPort 1.2, 1x HDMI 2, 1x HDMI 1.4, 1x MHL-HDMI, 1x DVI-D, 1x D-Sub

USB 1x USB 3 input, 2x USB 3 outputs

Speakers 2 x 3W speakers, 3.5mm in/out

Power supply Internal

OSD control Buttons

Extras AMD FreeSync support



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Iiyama ProLite X4071UHSU / £468 inc VAT

SUPPLIER www.scan.co.uk

The proper screen size for a display is always a matter of both personal taste and personal space. However, all the other displays on test this month are dwarfed by Iiyama's X4071UHSU-B1, which rivals TVs in terms of size. Indeed, it even includes a remote control. What's more, it appears to offer amazing value for money. The secret is its 10-bit MVA panel technology, which sits somewhere between TN and IPS in terms of capabilities. It has the good 178-degree viewing angles of IPS panels, with a 3ms response time, high contrast ratios and deep black levels.

With 4K, there's a practical benefit of using larger screens. With a 40in screen, you can use Windows as normal, without any need for scaling, with icons, text and graphics looking perfectly normal at their native resolution. Comparatively, even 32in 4K monitors require scaling to ensure usability.

Of course, being so large imposes some restrictions on the X4071UHSU-B1. The stand comes in two bracket-like pieces to support the 12kg screen on either side, and it isn't very flexible either. There's no way to make it pivot, rotate or move up and down. Worse, the brackets don't seem to fit securely onto the base, and they don't connect to the rear of the display either, so its weight makes it lean forward slightly.

Thankfully, though, VESA mounting is possible. It requires a 200 x 400mm mount, larger than the typical 100mm arms found on most screens, but we can certainly imagine businesses using such a screen for public information displays. In terms of connections, there's only a DisplayPort input, but you get three HDMI ports, including one HDMI 2 connector, and legacy VGA support is included too. There are also two USB 3 ports at the side and a pair of 6W speakers.

Meanwhile, the OSD is controlled with physical buttons located directly underneath the right-hand side.

The menu system itself is similar to the one on Iiyama's GB288UHSU (see p46), and it works well, and the picture-in-picture (PIP)



Icons, text and graphics look perfectly normal without scaling in Windows

mode, works brilliantly on such a massive screen. Iiyama has missed a trick by not going for a four-way PIP mode to display all four inputs at once, though, effectively giving you four 20in 1080p screens.

In our test results, the MVA screen of the X4071UHSU delivered the promised amazing contrast results, delivering a stunning ratio 3,180:1 and a black point of 0.12, the best blacks of any screen on test by a wide margin. It's bright too, with a result of 385cd/m² and, while the Spyder 5 recorded a high white point of 10,300, the gamma result was out by 0.1. Even the power consumption of 58W is respectable, being only slightly higher than that of 32in IPS screens.

Measured accuracy was also quite good, with 87 per cent Adobe RGB coverage and 100 per cent sRGB, although the uncalibrated delta E was around 2. MVA panel technology certainly has its benefits.

Conclusion

There's a subjective element to display testing that goes beyond simply flicking a

colorimeter over a screen, and in the case of the XB4071UHSU, the main issue is its size. Games look great on it from a few feet away, but it's overpowering if you're editing Word documents or browsing the Web up close. If you're looking for a 40in screen to hook up to a PC and a Sky box on your lounge wall (don't use the stand), the XB4071UHSU is great for the money, but for desktop use, we recommend stepping down to a screen that's no bigger than 32in.

IMAGE 39/50 **FEATURES** 12/20 **VALUE** 26/30

VERDICT

Great value if you want a monitor on your lounge wall, but it's too unwieldy to put on your desk.

OVERALL SCORE
77%

/ SPECIFICATIONS

Screen size 40in

Resolution 3,840 x 2,160

Panel tech MVA

Inputs 1x DisplayPort 1.2, 1x HDMI 2, 1x HDMI 1.4, 1x MHL-HDMI, 1x D-Sub

USB 1x USB w input, 2x USB 3 output

Speakers 2 x 6W speakers, 3.5mm in/out

Power supply Internal

OSD control Buttons



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A fresh take on technology

Philips Brilliance BDM3275UP / £620 inc VAT

SUPPLIER www.box.co.uk

Most people use their computers for a wide range of activities, including gaming, working, watching movies and web browsing. A good all-round display needs to cater for all of these options, while keeping an eye on value for money as well, and the Philips Brilliance BDM3275UP is a contender for this description. It's a massive 32in screen, with a 10-bit IPS panel and a 4ms response time. It also costs just £620 inc VAT, which is hardly pocket change, but it's decent value for money for a high-quality display of this size, costing less than some of the 27in and 28in IPS screens on test.

The OSD and menus are one of the strongest points of the BDM3275UP. The control system is very similar to the one used on the 34inch BDM3490UC (see p52), although in this case, touch-sensitive buttons are used for navigation rather than a joystick, unfortunately. The menu itself is still great, though, offering a wealth of settings to customise the on-screen image, including six colour temperatures from 5,000K to 11,500K. There are five gamma settings, seven 'SmartImage' colour presets and a two-way picture-in-picture (PIP) mode too.

In terms of connections, it has a pair of display inputs that can be used for a 60Hz 4K signal – DisplayPort and HDMI 2 – and you get VGA and DVI inputs too, although there are no extra HDMI connections and you also only get a two-port USB 3 hub.

Meanwhile, the stand is fully flexible, offering pivot, rotate, tilt and height adjustment, which is good to see. As with the Samsung UE32850R, swivelling the BDM3275UP into portrait mode looks a bit odd, given the screen size, but it works just fine. You can also remove the stand easily, giving you get access to a 100mm VESA mount.

From our test results, the Philips BDM3275UP is in a similar league to most of the IPS displays on test, putting on a good show in all areas. The brightness of 337cd/m² is a good result, but the contrast



The contrast particularly stands out as the best of any IPS display on test

particularly stands out as the best of any IPS display on test, with a cracking result of 760:1. Colour accuracy is also below 1, which is good to see, and the BDM3275UP supports 100 per cent sRGB and 80 per cent Adobe RGB gamuts. The gamma result was spot on too.

Subjectively, we found gaming and desktop use worked just fine on the BDM3275UP, with images looking very bright and colourful. It all adds up to a solid all-round PC monitor.

Conclusion

If you have room on your desk for a 32in display, the Philips BDM3275UP offers great value. It has a bright picture, as you would expect from an IPS panel, with excellent contrast and good colour accuracy. While its image quality doesn't quite measure up to the colour-accurate screens, it's also

very good value for money, when you consider the screen size. The OSD is also superb, with lots of useful settings in the menus, even if you don't get joystick control, and there's a highly flexible stand too. Aside from the use of touch-sensitive buttons and the slightly slim set of video inputs capable of 60Hz 4K, it's a great monitor for the money.

IMAGE 43/50 **FEATURES** 15/20 **VALUE** 23/30

VERDICT

If you have room for a 32in monitor, this is a great quality display for a good price.

OVERALL SCORE
81%

/ SPECIFICATIONS

Screen size 32in

Resolution 3,840 x 1,440

Panel tech IPS

Inputs 1x DisplayPort 1.2, 1x HDMI 2, 1x DVI, 1x D-Sub

USB 1x USB input, 2 x USB 3 output

Speakers 2 x speakers, 3.5mm in/out

Power supply Internal

OSD control Touch



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CURVED ULTRA-WIDE MONITOR

Philips Brilliance BDM3490UC / £697 inc VAT

SUPPLIER www.amazon.co.uk

Most of this Labs test has been dedicated to 4K screens with the same 16:9 widescreen aspect ratio as 1080p displays, but there's an alternative option, in the form of 21:9 ultra-wide curved displays, such as the 34-inch Philips BDM3490UC. With a resolution of 3,440 x 1,440, the overall pixel count is much lower than that of a 4K panel. It's precisely 880 pixels wider than a 2,560 x 1,440 screen, with 440 pixels added to each side. The Philips is also curved at the edges, bringing the sides slightly more in line with your peripheral vision.

Curved 21:9 displays provide a more cinematic view of movies, particularly with modern titles that have been filmed in this aspect ratio. They also provide more width than a standard 2,560 x 1,440 16:9 screen, enabling you to have few applications comfortably spaced on-screen at the same time. It's like having a multi-monitor setup, but with a single large screen rather than two. The screen is wide enough to have two web pages next to each other, and still look absolutely normal. It's also great for immersive gaming, occupying nearly all of your peripheral vision.

The Philips has an IPS panel with 10-bit colour processing, derived from 8 bits with a dithering technique. Meanwhile, the display's curvature is described as 3800R, referring to the complete radius (in millimetres) of a circle formed by ultra-curved monitors if they were placed next to each other.

The overall design is impeccable. Philips has opted for a dark grey front and glossy white plastic casing at the rear, which looks great and feels lovely to touch, with a solid metal crescent-shaped stand, which has a very wide plastic base to support the weight of the display.

There's an overall theme of white, with a white external power supply and even white cabling supplied in the box. The only negative design point is the stand's lack of flexibility, there's no height adjustment or rotation, although it will tilt forwards and backwards.



The OSD is controlled with a four-way joystick underneath the display, which is by far our favourite control system for menu systems on monitors. A quick push in any direction brings up shortcuts, with a push to the right leading to a main menu offering the rest of the settings.

In the OSD menu system, you'll find a similar number of options and settings as with the 4K Philips BDM3275UP (see p50), including the same wide range of presets for both white points (Kelvin values) and colour modes; there's also a PIP mode.

As with 4K, for 60Hz use on a 3,440 x 1,440 display, you need to use either the DisplayPort 1.2 or HDMI 2 inputs. There's an additional pair of HDMI 1.4 inputs as well, along with a four-port USB hub. By default, you'll need to enable either DisplayPort 1.2 or HDMI 2 in the menus though. The display from an HDMI device also looks stretched unless you force the picture mode to 16:9 in the menu.

Unlike most monitor speakers, the Philips' two 7W speakers also deserve a mention, as they sound surprisingly good, and their support for DTS audio enables virtual surround sound too.

Subjectively, the picture appears bright, with great contrast, and this perception was backed up by good test results, showing 342cd/m² brightness and 750:1 contrast. Out-of-the-box colour accuracy shows a delta E under 1, which is a great result.

Meanwhile, the display managed sRGB and Adobe coverage of 100 per cent and 79 per cent respectively, which is typical of most IPS displays. Average deviation across the panel is below 9 per cent as well.

Conclusion

This ultra-wide 34in screen is huge, but it has an excellent design and a great picture. If you have room for it then it's a solid alternative to a traditional 16:9 4K screen, or a dual-display setup.

IMAGE 43/50 **FEATURES** 16/20 **VALUE** 21/30

VERDICT

Decent image quality and design make this screen a great alternative to traditional 16:9 displays.

OVERALL SCORE
80%

/ SPECIFICATIONS

Screen size 34in (219) curved

Resolution 3,440 x 1,440

Panel tech IPS

Inputs DisplayPort 1.2, HDMI 2, MHL-HDMI, HDMI 1.4

USB 1 x USB 3 input, 4 x USB 3 outputs

Speakers 2 x 7W with DTS audio, 3.5mm in/out

Power supply External

OSD control Joystick

Samsung UE32850R / £750 inc VAT

SUPPLIER www.overclockers.co.uk

Gamers with Nvidia GPUs have the option of a great 4K display in the form of the Asus PG27AQ (see p42), a 27in IPS model that supports G-Sync. For gamers with AMD GPUs, though, there are three displays on test that support FreeSync, but only the Samsung U32E850R has an IPS panel (Samsung calls this technology PLS, but it effectively works the same way as IPS). Not only that, but it has a 32in diagonal too.

The large panel features 10-bit colour, derived from the now-common 8-bit processing with software enhancements. The unit is impressively built as well, made from a combination of strong dark grey plastic and a metal band running around the middle, resulting in a premium look and feel. The stand is tough and rigid too, and capable of a full range of motion. You can adjust the height, rotate it on the spot, tilt it backwards and forwards and, despite supporting a massive 32in screen, you can even swivel it into portrait mode. There are 100mm VESA mounting holes for alternative mounts too.

There are no built-in speakers, but audio is instead supported via an optional sound bar, knocking money off the asking price for anyone who would prefer to use their own sound system, but providing the option for users who prefer to have a sound system in their monitor. Otherwise, there's a good range of features. Video inputs are particularly strong, with an all-digital array of DisplayPort, mini DisplayPort and two HDMI 2 inputs.

Meanwhile, the OSD is controlled using five small rectangular buttons located at the front, rather than behind or underneath the bezel. They're a good size, being small enough to not be unsightly, but easy to press and use for navigation through the menus. There's also a picture-in-picture (PIP) mode available here.

There's also FreeSync support, which would be a good feature on a sub-4K display, but at 4K, FreeSync doesn't kick in until your frame rate hits 40-60Hz, which is going to require some serious GPU muscle. When it's working, FreeSync eradicates tearing and stuttering issue in games, and it looks great, but the refresh rate limit really hampers its usefulness on a 4K display.

The UE32850R presents a great picture too, although in use, it isn't quite as bright or



The stand is tough, rigid, and capable of a full range of motion

vibrant as the ViewSonic VP2780-4K or the Dell UP2715K. Samsung sells high-end displays to compete with these more colour-accurate screens, although they obviously cost more. We recorded some great results too, with brightness levels of 406cd/m² and a contrast ratio of 670:1. Gamma was off by 0.1 with a mean brightness deviation of 8 per cent, while uncalibrated colour accuracy is just over a delta E of 2, although this result was corrected to under 1 with calibration – you'll need a colorimeter to get this colour accuracy yourself, though. Notably, we also measured the third highest Adobe RGB coverage of 84 per cent from the Samsung UE32850R.

Conclusion

The Samsung UE32850R directly competes with the Philips Brilliance BDM3275UP. Both screens are 32in 4K IPS displays, and both have very similar features and excellent picture quality. However, its £750 inc VAT asking price makes it significantly pricier than

the Philips. The Samsung admittedly supports FreeSync, but the 40Hz minimum refresh rate it requires means this feature will only be useful if you have a serious multi-GPU setup. The UE32850R is a great monitor, but for most people, the Philips BDM3275UP will do the same job for a much cheaper price.

IMAGE 42/50 FEATURES 16/20 VALUE 20/30

VERDICT

Solid build and image quality, but Philips' similar Brilliance BDM3275UP is cheaper.

OVERALL SCORE
78%

SPECIFICATIONS

Screen size 32in

Resolution 3,840 x 2,160

Panel tech IPS

Inputs 1x DisplayPort 1.2, 1x mini DisplayPort, 2x HDMI 2

USB 1x USB 3 input, 3 x USB 3 outputs

Speakers 3.5mm in/out, optional soundbar

Power supply Internal

OSD control Buttons

Extras AMD FreeSync support

ViewSonic VP2780-4K / **£699** inc VAT*****
SUPPLIER www.dabs.com

When a manufacturer says a display is designed for professional graphics work, it isn't just a label they can stick on the box to justify an inflated price. Using a colorimeter, we can compare the brightness levels, contrast and colour reproduction of a screen to see how it measures up with more affordable displays. In most cases, it's easy to see where the extra money goes.

The ViewSonic VP2780-4K is one such professional-grade display, competing with the likes of the Dell UP2715K, but clocking in at a lower overall price. Indeed, while the £699 inc VAT price is higher than that of most displays on test, its specification is generally better than a typical IPS screen. It has a 10-bit panel with a quoted response time of 5ms and 178-degree viewing angles.

It isn't the most exciting-looking monitor though. It has an enormous three-point stand and a dark grey finish all over, with chunky bezels surrounding the screen. It all feels very professional and sensible, with none of the red trim of the Asus PG27AQ or the shiny design of the Acer S277HK.

Meanwhile, the OSD is controlled with touch-sensitive buttons. Touch is a perfect interface for smartphones and tablets, but we're not sure the lack of tactile feedback works so well on displays.

The overall design has been kept simple, with a pair of buttons labelled 1 and 2, then two more for up and down. It takes a while to get used to it, but muscle memory soon makes it quite simple to navigate, aided by the straightforward lists of settings.

Oddly, there are no gamma or Kelvin presets, but instead a more consumer-friendly list of seven named presets and six colour settings. It isn't a bad OSD control system, but Philips and Asus have the upper hand in this respect.

In terms of inputs, the VP2780-4K offers nearly a full house, including DisplayPort, mini-DisplayPort, HDMI 2 and HDMI 1.4. It also has a very flexible stand that pivots, tilts, swivels and rotates, and there's a unique 4-way picture-in-picture (PIP) mode, which enables you to view all four inputs on screen at once. You also get four USB 3 ports, although there are no built-in speakers.



It was the brightest display on test, with a colorimeter result of 412.5cd/m^2

It's the test results that really speak volumes about the quality of the VP2780-4K though. It was the brightest display on test, with a result of 412.5cd/m^2 , along with contrast levels of 620:1. It has the most even brightness distribution of any display on test as well, with an average of just 2.1 per cent, an incredible achievement. Colour accuracy was the best of any display we tested as well, with a delta E of 0.41 right out of the box, and its default gamma hit 2.2 exactly, with no deviation on either side, a feat managed by only three other displays on test. Subjectively, the picture looks fantastic too. The only slight downside, surprisingly, was the RGB coverage. We only measured 98 per cent sRGB coverage rather than 100 per cent, and the Adobe RGB coverage is lower than other screens, at 75 per cent.

Conclusion

The VP2780-4K offers a notably brighter picture

than many of the other displays, presenting a really crisp image.

The outstanding image quality and colours on the Dell UltraSharp UP2715K (see p44) are superior, but the majority of the other displays on test look less vivid, and the 4K ViewSonic is significantly cheaper than the Dell too. The ViewSonic VP1780-4K's quality is arguably overkill for gaming, but it's a superb 4K monitor if brightness and image quality are your main concerns.

| IMAGE | FEATURES | VALUE |
|-------|----------|-------|
| 46/50 | 15/20 | 21/30 |

VERDICT

Overkill for gaming and pricey, but the ViewSonic offers great image quality and features.

OVERALL SCORE
82%

/ SPECIFICATIONS

Screen size 27in

Resolution 3,840 x 2,160

Panel tech IPS

Inputs 1x DisplayPort, 1x mini-DisplayPort, 1x HDMI 2, 1x HDMI 1.4

USB 1x USB 3 input, 4 x USB 3 outputs

Audio 3 5mm output, no speakers

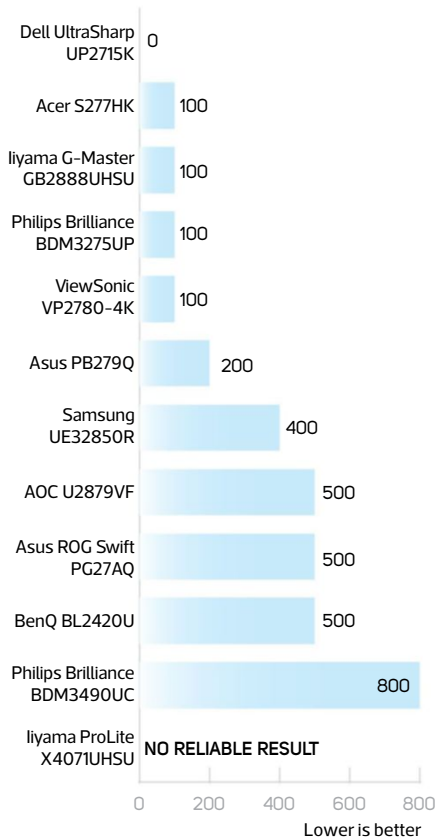
Power supply External

OSD control Touch



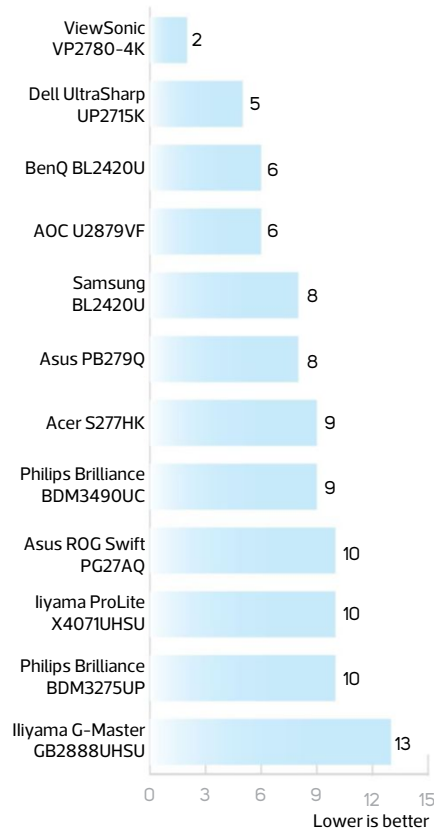
COLOUR TEMPERATURE (KELVIN)

Deviation from ideal result (6,500K)



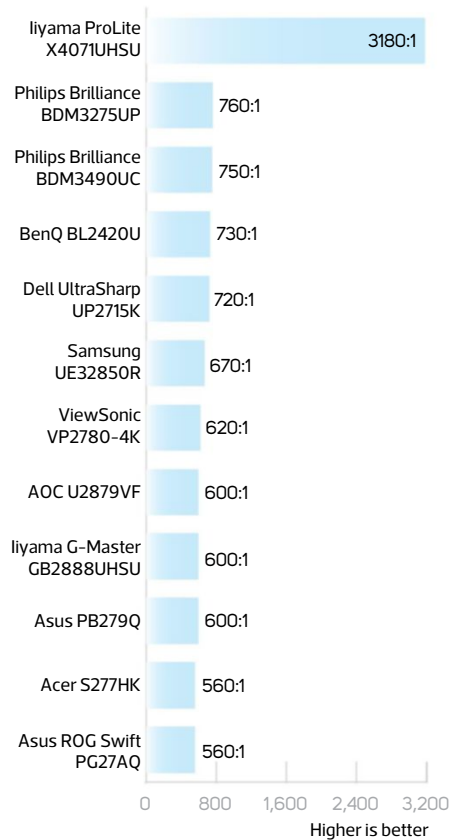
BRIGHTNESS UNIFORMITY (AVERAGE PER CENT)

Mean deviation



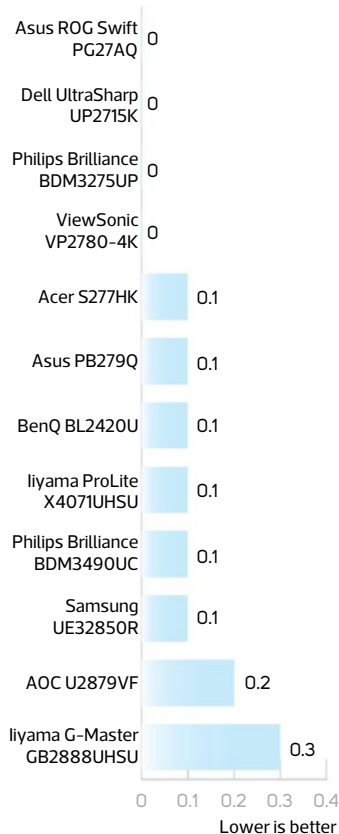
CONTRAST RATIO

Ratio of white-to-black luminance



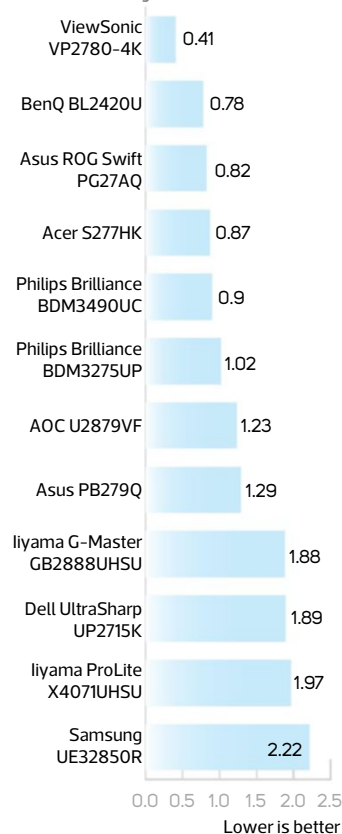
AVERAGE GAMMA

Deviation from ideal result (2.2)



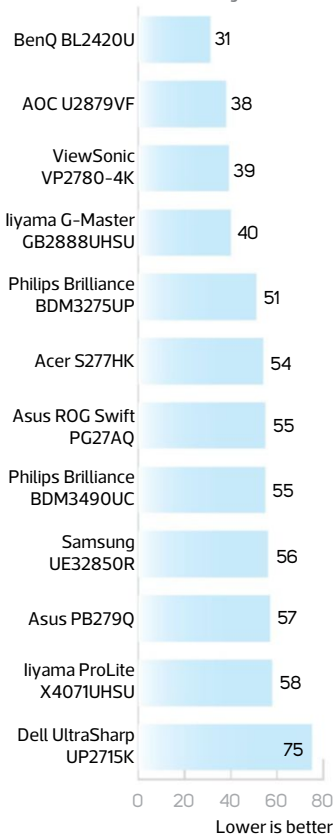
UNCALIBRATED COLOUR ACCURACY

Average delta-E 2000



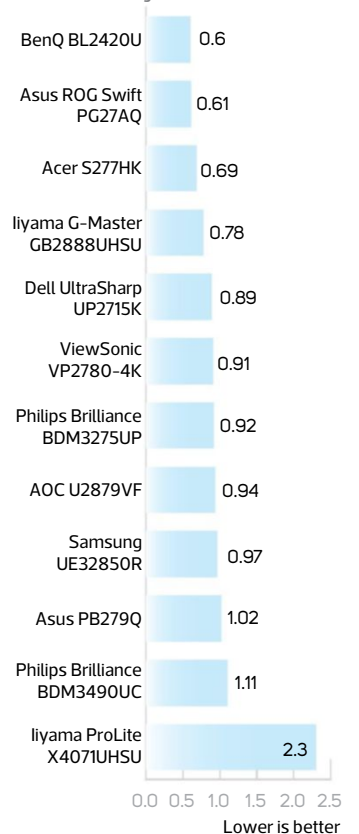
POWER CONSUMPTION (WATTS)

White screen at max brightness



CALIBRATED COLOUR ACCURACY

Average delta E 2000



PC system reviews

GAMING PC

Computer Planet Fusion X7 GT / £1,499 inc VAT

SUPPLIER www.computerplanet.co.uk

Computer Planet's Fusion X7 GT has flamboyant green design that really makes it stand out. The fans on the Corsair Hydro H80i and two intake fans are equipped with green LEDs, and a strip of lights sits behind the raised section in the middle of the case. Meanwhile, the MSI GTX 980 Ti card has been fitted with a green-accented cooler, and the NZXT S340 case has a huge Razer decal down one side and green lights on the base. Even the Gigabyte GA-Z97X-Game Plus motherboard has green heatsinks.

Not only that, but the Corsair RAM is topped with green heatsinks and the cable ties are green. Even the motherboard screws have been painted. Computer Planet has also swapped the side panel for a windowed version to show off the interior.

The NZXT S340 is a great case, of course, being on our Elite list for over a year, and Computer Planet has used a special Razer edition with a tinted window and lots of green Razer touches. The PSU, cables and storage rack are hidden

behind a dark aluminium shroud, and every air intake has a dust filter. Around 90 per cent of the chassis is made from steel too, so build quality is impressive. The only notable downer for some people is that there's no 5.25in bay for an optical drive.

The specification is a mixed bag though. The most exciting component is the MSI GTX 980 Ti card, which should enable borderline playable frame rates in games at 4K. It has three speed modes; the Silent option maintains stock speeds and the Gaming mode – which Computer Planet uses – ups the clock to 1140MHz. The most demanding option is OC mode, which runs the core at 1178MHz.

Meanwhile, processing power comes from Intel's Core i7-4790K. It's a powerful quad-core part with Hyper-Threading and loads of cache, and Computer Planet has overclocked the 4GHz chip to 4.6GHz. It's an older chip than today's current Skylake CPUs, though, being based on Intel's Haswell architecture.

The use of an older CPU also means use of an older chipset, and in this case, you get a Z97



Gigabyte board, which offers dedicated audio circuitry and also includes an M.2 slot. However, the latter is limited to using two PCI-E 2 lanes, rather than the four PCI-E 3 lanes available on Skylake boards. It covers all the basics, but it lacks enthusiast features such as a clear-CMOS button, on-board power and reset switches, or a POST code display and it also lacks USB 3.1 support. The machine also sports 16GB of DDR3 memory, which is plenty, and despite being DDR3, it runs at a decent speed of 2400MHz too. Meanwhile, the PSU is a 750W Corsair RMX model, which features 80 Plus Gold certification – a cut above the bottom-end PSUs we often see in review machines.

The biggest issue, though, is storage. There's just a 240GB Mushkin Chronos G2 SSD, and no hard disk. That SSD won't be competitive in terms of speed, and the lack of any extra capacity is going to limit the number of games you can install, let alone any extra data you want to store locally. You might expect such a storage system in a budget PC, but not in a £1,499 GTX 980 Ti gaming rig.

Finally, Computer Planet's warranty is a three year deal, which includes two years of collect and return service that covers both parts and labour – a good deal.

Performance

With its GeForce GTX 980 Ti, all our game tests were great at 2,560 x 1,440, with Crysis 3 and Fallout 4 never dropping below 50fps. Even 4K gaming is possible, with The Witcher 3 minimum of 36fps being fine, and the 26fps minimum in Fallout 4 being borderline playable – dropping the settings from Ultra to High will easily make this game smooth. Crysis 3 didn't quite hit our 25fps minimum target, but it wasn't far off – a little tweaking will make this game playable.

Thanks to a hefty CPU overclock, the Fusion is also plenty fast enough in our application benchmarks, being nearly 16 per cent quicker than our reference PC. As a point of comparison, though, the CyberPower Infinity X77 Deluxe (see Issue 150, p56) has a Skylake Core i7-6700K overclocked to 4.7GHz, and managed a score of 329,911 in our video encoding benchmark, compared to the Computer Planet's 287,027. Of course, the CyberPower is much pricier, and Skylake Core i7 CPUs are currently expensive, but you pay a small performance sacrifice by opting for a last-gen

/SPECIFICATIONS

CPU 4GHz Intel Core i7-4790K
overclocked to 4.6GHz

Motherboard Gigabyte
GA-Z97X-Game Plus

Memory 16GB 2400MHz
Corsair Vengeance Pro DDR3

Graphics MSI GeForce GTX
980 Ti 6GB+

Storage 240GB Mushkin
Chronos G2 SSD

Case NZXT S340 Razer

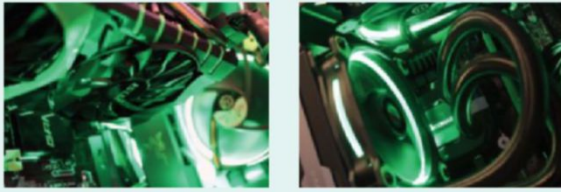
Cooling CPU: Corsair Hydro
H80i GT with 2 x 120mm fans;
front: 2 x 120mm fans; roof:
1 x 120mm fan

PSU Corsair RM750X

Ports Front: 2 x USB 3, 1 x
audio; rear: 4 x USB 3, 4 x USB
2, 2 x PS/2, 1 x Gigabit Ethernet,
1 x optical S/PDIF, 5 x audio

Operating system Windows 10
Home 64-bit

Warranty Two years parts and
labour collect and return,
followed by one year labour
only return to base



CPU. For most people, the difference is negligible, though, and it will make little difference to games.

Meanwhile, the Mushkin SSD struggled through our sequential read and write tests to speeds of 364MB/sec and 187MB/sec respectively, being a long way behind even the best SATA SSDs, such as the Samsung 850 Evo or even the Crucial BX100, let alone PCI-E drives. It's quicker than a hard disk, but you can definitely find much quicker drives and, when you combine this speed with the system's disappointing lack of storage capacity, it's clear that storage is the main issue for this system.

The Fusion gets toasty too. Its CPU delta T of 69°C came from a peak CPU temperature of 92°C, which is very high. The noise output was consistently noticeable too, with the fans churning out an obvious rumble, even when the PC was idle. Thankfully, the fan noise didn't modulate up and down in games like some machines, but it would be much better if it stayed quiet when its components weren't taxed.

Conclusion

Computer Planet's Fusion X7 GT gets a lot right. It looks fantastic, and it's great to see so much attention paid to colour-matching components. It's also amazing to see a



- 1 It's great to see a GeForce GTX 980 Ti card in a sub-£1,500 machine
- 2 The two intake fans have green LEDs, and there are green touches everywhere else too
- 3 The PSU, cables and storage rack are hidden behind a dark shroud

GeForce GTX 980 Ti card included in a sub-£1,500 machine, resulting in some great gaming performance, plus you get 16GB of RAM, a decent PSU and solid warranty coverage.

The system is unbalanced though. The storage setup is particularly disappointing when you consider the size of some of today's game installs. It's worth paying extra for a faster and higher-capacity SSD here. With a little tweaking, the Fusion X7 GT would be a great, attractive machine, even at a higher price, but it's too unbalanced in its current form.

MIKE JENNINGS

CPC REALBENCH 2015

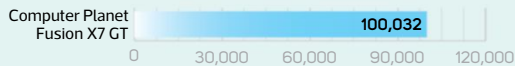
GIMP IMAGE EDITING



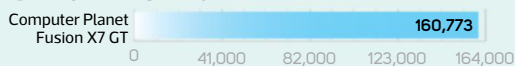
HANDBRAKE H.264 VIDEO ENCODING



LUXMARK OPENCL



HEAVY MULTITASKING



SYSTEM SCORE



INTEL REFERENCE: 115.99%

SPEED
23/25

DESIGN
23/25

HARDWARE
18/25

VALUE
19/25

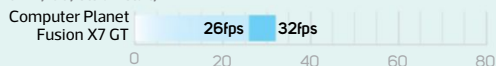
OVERALL SCORE
83%

FALLOUT 4

2,560 x 1,440, Ultra Detail, TAA

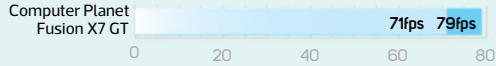


3,840 x 2,160, Ultra Detail, TAA

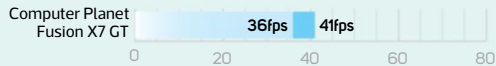


WITCHER 3

2,560 x 1,440, High Detail, AA on

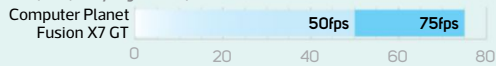


3,840 x 2,160, High Detail, AA on

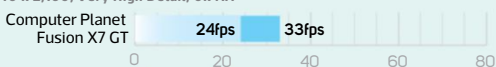


CRYSIS 3

2,560 x 1,440, Very High Detail, 0x AA



3,840 x 2,160, Very High Detail, 0x AA



Minimum Average

VERDICT

Great looks and amazing speed in games, but this system is hampered by compromises in other areas.

GAMING PC

Oblivion Systems Guardian / £1,270 inc VAT

SUPPLIER www.oblivionsystems.co.uk

We're used to water-cooled machines with striking colour schemes, but Oblivion Systems' Guardian really stands out with its bold, pink coolant. The interior of the Phanteks chassis is dominated by a pair of coolant tubes that wind from the roof-mounted Raijintek Triton 280 to the chunky CPU block on top of the Skylake Core i5-6600K CPU. Both tubes ripple with bright pink Mayhems coolant, which is then lit up by the CPU block's LED.

Likewise, the main PSU power cables are individually braided in pink and grey. There's no doubt the Guardian's interior looks top-notch. The pink cooling is striking, and Oblivion has taken obvious care over the build too. That said, we wish Oblivion had done more. The large window on the Phanteks Enthoo Evolv's side panel is tinted, and Oblivion hasn't added any extra lights, which makes the Guardian look gloomy when, in reality, it's anything but.

Still, there's plenty to like – and the interior's impressive start goes beyond the visuals. A Phanteks-branded shroud

stretches across the base of the Enthoo and hides the PSU, hard disk and any spare cables, which leaves the front of the chassis free for airflow from three 120mm fans. The 3mm aluminium used throughout the case is rock-solid and looks good thanks to a gunmetal finish, and its subtle angles and meshed areas look smart. The quick-release side panels are a boon too.

The non-intrusive cable work means it's easy to get at the Guardian's components and upgrade paths as well. There are two accessible, empty memory slots, and every spare expansion slot is free, including three 1x PCI-E slots and two empty 16x PCI-E slots. Around the back you'll also find a spare hard disk bay and two empty 2.5in mounts.

Oblivion has built this system with a well-rounded set of components. The GTX 970 has 1,664 stream processors, and this KFA² Infin8 Black Edition card has been tweaked by Overclockers to deliver more performance, winning it an award in last month's Labs test (see Issue 150, p42). The 1050MHz base clock has been improved to 1178MHz, and its boost clock now runs at a peak of 1329MHz.

Meanwhile, the 3.5GHz Core i5-6600K has been overclocked to 4.5GHz, with a 1.35V

vcore. There's also 16GB of Team Group DDR4 memory, and it runs at a super-fast frequency of 3200MHz too. There's an M.2 SSD as well, but don't get your hopes up – it's a SATA model, rather than a new super-quick NVMe drive, although this 256GB Samsung 850 Evo drive is still at the upper end of SATA performance. There's a 1TB hard disk for extra data storage too.

All the components hook up to an Asus Maximus VIII Hero motherboard, which is one of the top LGA1151 ATX boards around, and it's brimming with features. Its audio circuits are shielded, and there are on-board power and reset buttons, plus a two-character

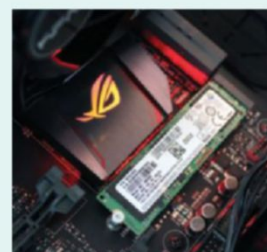
POST display. You can even change the colour of the Republic of Gamers logo, and make it pulse. Its backplate pairs two USB 3 ports with USB 3.1 Type-A and Type-C connectors, and it also has four USB 2 connectors, a PS/2 port, five audio jacks and an optical S/PDIF connector. It doesn't just excel on a practical level either – with its gunmetal shrouds and black PCB, it looks the part.

Finally, Oblivion sells this system with a two year warranty that includes both parts and labour, which is a mixed bag. It's great to get two years of parts coverage, but it would also be good to get some collect and return cover at the beginning.

Performance

The overclocked GTX 970 card resulted in some great frame rates at 1080p and 2,560 x 1,440; however, not surprisingly, none of our test games managed playable frame rates at 4K. That said, the Oblivion happily handled Fallout 4's Ultra graphics settings at 1080p and 2,560 x 1,440, with minimums of 55fps and 33fps respectively.

The Guardian's gaming prowess was bolstered by our Witcher 3 test at High settings, where it never dropped below a silky-smooth 71fps at 1080p, and managed a decent 46fps minimum at 2,560 x 1,440, giving you some headroom to enable extra features such as HairWorks. Oblivion's machine fared well in our aging but challenging Crysis 3 test too, staying above 30fps at 2,560 x 1,440.



/SPECIFICATIONS

CPU 3.5GHz Intel Core i5-6600K overclocked to 4.5GHz

Motherboard Asus Maximus VIII Hero

Memory 16GB Team Group Dark Pro 3200MHz DDR4

Graphics KFA² GeForce GTX 970 OC 4GB

Storage Samsung 850 Evo 256GB M.2 SSD, Western Digital Caviar Blue 1TB hard disk

Case Phanteks Enthoo Evolv ATX

Cooling CPU: Raijintek Triton 280 with 2 x 140mm fans; front: 3 x 120mm fans; rear: 1 x 120mm fan

PSU Super Flower Leadex Gold 650W

Ports Front: 2 x USB 3, 2 x audio; rear: 2 x USB 3, 1 x USB 3.1 Type-A, 1 x USB 3.1 Type-C, 4 x USB 2, 1 x PS/2, 1 x Gigabit Ethernet, 1 x optical S/PDIF, 5 x audio

Operating system Microsoft Windows 10 Home 64-bit

Warranty Two years of return to base cover, including parts and labour

The overclocked Core i5-6600K held its own in our RealBench 2015 suite as well. Its extra clock speed pushed it towards an image editing score 60,971, which is more than 3,000 points beyond the Overclockers Titan Wave (see Issue 148, p60), with its 6-core Core i7-5820K chip. Not surprisingly, the six cores inside the Overclockers system proved dominant elsewhere though. The Guardian's score of 263,808 in our heavily multi-threaded video encoding test was around 100,000 points behind the Titan Wave, for example, although its multi-threaded performance is still fine for most people's needs, including gaming.

Meanwhile, the conventional SATA SSD rattled through our read and write tests at 494MB/sec and 479MB/sec, which isn't anything to write home about in these days of NVMe drives, but they're still significantly quicker than a mechanical hard drive.

This machine's heat output was never a problem either. The processor peaked with a modest delta E of 49°C after prolonged stress testing, and the GPU delta T of just 37°C was even chillier. Noise, though, wasn't as impressive. The Oblivion maintained a constant low rumble, no matter what the task – even when idle, its churning fans were noticeably audible. It's on a par with the worst excesses of the Titan Wave's noise, even when the system wasn't being stressed.

Conclusion

The Oblivion Systems Guardian is a striking machine, thanks to its pink touches and smart case, and it pairs its good looks with solid build and good performance in most areas. The overclocked Core i5 chip is consistently quick, and the



- 1 The clear tubes ripple with bright pink Mayhems coolant
- 2 The KFA² Infin8 Black Edition card has been tweaked by Overclockers
- 3 A Phanteks-branded shroud stretches across the base, hiding the PSU, hard disk and any spare cables

tweaked GTX 970 has the power to play games at decent settings at 2,560 x 1,440.

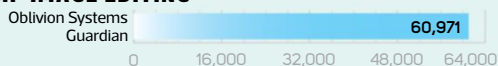
Our issues with this machine are small niggles rather than ruinous problems. The flashy interior could do with being lit up properly, the SSD could be quicker and the machine needs to be less noisy too.

Nonetheless, the Guardian is a great-looking, well-balanced and well-built gaming PC. If fan noise doesn't bother you, and you're drawn to the pink touches, the Guardian is worth considering, especially at this price.

MIKE JENNINGS

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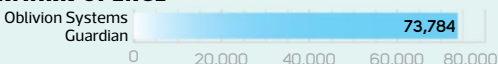
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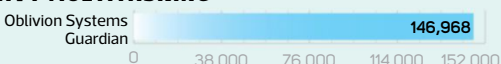
HANDBRAKE H.264 VIDEO ENCODING



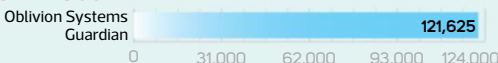
LUXMARK OPENCL



HEAVY MULTITASKING



SYSTEM SCORE



INTEL REFERENCE: 106.27%

SPEED
19/25

HARDWARE
21/25

DESIGN
21/25

VALUE
22/25

OVERALL SCORE
83%

FALLOUT 4

1,920 x 1,080, High Detail, TAA



2,560 x 1,440, High Detail, TAA



THE WITCHER 3

1,920 x 1,080, High Detail, AA on

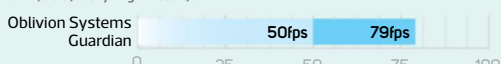


2,560 x 1,440, High Detail, AA on

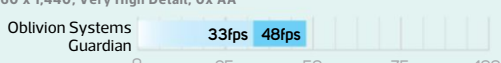


CRYSIS 3

1,920 x 1,080, Very High Detail, 0x AA



2,560 x 1,440, Very High Detail, 0x AA



Minimum Average

VERDICT

Fast in key areas and good-looking, the Gladiator is well-balanced and affordable, if a bit noisy.

GAMING PC

Scan 3XS Z170 Vengeance Q / £1,500 inc VAT

SUPPLIER www.scan.co.uk

The latest machine to arrive from Scan's Bolton factory is a high-end gaming system designed for minimal noise, and its processor initially looks an odd choice. The Core i7-6700 doesn't have the unlocked multiplier or the i7-6700K, and its 3.4GHz base clock only Turbo Boosts to 4GHz. What it does have, though, is a 65W TDP – far lower than the 91W of the K-edition chip.

Scan has chosen a more frugal CPU in order to deploy Noctua's superb NH-D15 heatsink. That cooler is designed for low noise; heat is spread by six heatpipes over two huge towers, and its pair of 140mm fans can then afford to spin at low speeds. Also, while the i7-6700 doesn't have an unlocked multiplier, that hasn't stopped Scan from doing a little tweaking. The firm has upped the base clock from 100MHz to 102.25MHz, raising the chip's Turbo peak to 4.09GHz.

Meanwhile, the graphics card has been chosen for its keen balance between power and low noise. The EVGA-made GTX 980 is a SuperClocked card with an ACX 2.0 cooler. The former feature means the original base clock of 1126MHz has been improved by 100MHz, and the latter

feature means it's equipped with a low-power motor, optimised fan blades and double ball bearings – all modifications designed to make the card quieter. The Corsair RMX power supply is another carefully chosen component. Its fans only spin when the system is consuming more than 260W, and even then, it's very quiet.

Elsewhere, there's 16GB of Corsair Vengeance memory, and no sign of a hard disk with its slow and noisy moving parts. Instead, Scan has opted for a 960GB SanDisk Ultra II SSD. That's large for an SSD, but it might feel cramped if you have a massive media collection.

It's all plugged into an Asus Z170 Pro Gaming motherboard, which is a solid mid-range choice. It accepts up to 64GB of DDR4 memory and has ample free slots – including an M.2 port that accepts PCI-E NVMe storage. It has dedicated audio circuitry too, and its I/O panel also has four USB 3 ports and USB 3.1 Type-A and Type-C connectors. It's only missing the cosmetic touches and high-end tweaking features that you find on enthusiast

boards, and they're not particularly important on a PC that's unlikely to be overclocked, and doesn't have a side panel window either.

The case in question is a Corsair Carbide 400Q, which is designed for quiet operation: its panels are coated with noise-dampening material, and Scan has fitted 140mm and 120mm Noctua fans for the intake and exhaust. It's decent in other areas too. The PSU is hidden beneath a shroud and Scan has fastidiously ensured that cables are routed in regimented lines. It looks dark and smart, and it isn't too large either – measuring just 215mm wide and 464mm tall – so it can easily sit under

a desk or beside a TV without drawing any attention.

Its drive bays are all tool-free, and there are pairs of 16x and 1x PCI-E slots vacant beneath the graphics card. The only slight issue with layout is that the size of the quiet components prevents easy access to some upgrade paths – the free memory slots and SATA connectors are blocked by the Noctua heatsink and EVGA GPU, for example.

Finally, the Scan's standard warranty is a three-year deal with a year of onsite coverage followed by two years of return to base protection, with both parts and labour covered for the whole lot – it's a great deal.

Performance

Despite its low-noise design, the Vengeance Q produced great frame rates in all our test games at 1080p and 2,560 x 1,440, and it even managed borderline playable frame rates in Fallout 4 and The Witcher 3 at 4K with High detail.

The Scan's i7-6700 impressed in application benchmarks too. Its image editing score of 60,153 is rapid, and its multi-tasking pace of 161,984 is solid too. The Scan's overall result of 126,419 is great – clearly, you can get more speed from an overclocked PC with a K-series chip, but the Vengeance Q still offers plenty of power for most people's needs, and it's 10 per cent faster than our reference rig as well.

Crucially, the Scan machine delivered its consistently great benchmark results without making a racket. When it's idle, the Scan might as well be a passively cooled PC. The only way we could hear fan noise from was by pressing our ears right up against the side panels and, even then, the system only produced a barely detectable low hum. If you're in a room with music or games playing then the system won't be audible. Even typing will drown it out.

The situation is still deeply impressive during stress tests. With the CPU and GPU running at 100 per cent load, the



/SPECIFICATIONS

CPU 3.4GHz Intel Core i7-6700
overclocked to 3.48GHz

Motherboard Asus Z170 Pro
Gaming

Memory 16GB 3000MHz
Corsair Vengeance LPX DDR4

Graphics EVGA GeForce GTX
980 4GB

Storage 960GB SanDisk
Ultra II SSD

Case Corsair Carbide 400Q

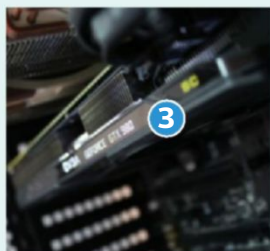
Cooling CPU: Noctua NH-D15
with two 140mm fans; GPU: 2 x
90mm fans; front: 1 x 140mm
fan; rear: 1 x 120mm fan

PSU Corsair RMX 650W

Ports Front: 2 x USB 3, 2 x audio;
rear: 4 x USB 3, 1 x USB 3.1
Type-A, 1 x USB 3.1 Type-C,
2 x USB 2, 1 x PS/2, 1 x Gigabit
Ethernet, 1 x optical S/PDIF,
5 x audio

Operating system Microsoft
Windows 10 Home 64-bit

Warranty Three years parts and
labour, with one year onsite and
two years return to base



- 1** The Noctua NH-D15 might be massive, but it's exceptionally quiet in operation
- 2** The PSU and its cables sit under a shroud, making for a tidy build
- 3** The EVGA graphics cooler has a low-power motor and double ball bearings

Scan's consistent low hum was only a little louder than the noise produced when the PC was idle. Temperature as never cause for concern either. The CPU and GPU delta Ts of 49°C and 54°C are fine, and the processor never throttled below 3.4GHz even when every core was pushed to its limit.

The only slightly disappointing performance result came from the SanDisk SSD, which ran through our sequential read and write tests at speeds of 499MB/sec and 366MB/sec respectively. The latter isn't great compared with other SSDs on the market, although it's still significantly quicker than any platter-based disk.

Conclusion

Scan tested three PSUs, a trio of heatsinks and four different case fan combinations to find the best component combination for this system, and it's clear that the firm's hard



work has paid off. The 3XS Z170 Vengeance Q is virtually silent when idle, and the noise barely increased when we pushed its high-end components to their limits. The Vengeance Q is also well made, and quick in both applications and games, despite the low-noise operation. There are obviously faster PCs available, but if quiet operation is your top priority, the Vengeance Q is both powerful and exceptionally quiet.

MIKE JENNINGS

CPC REALBENCH 2015 GIMP IMAGE EDITING



HANDBRAKE H.264 VIDEO ENCODING



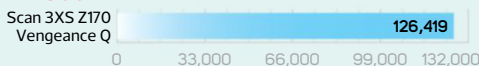
LUXMARK OPENCL



HEAVY MULTITASKING



SYSTEM SCORE



INTEL REFERENCE: 110.45%

SPEED
22/25

DESIGN
24/25

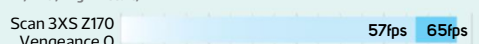
HARDWARE
22/25

VALUE
21/25

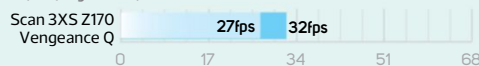
OVERALL SCORE
89%

FALLOUT 4

2,560 x 1,440, High Detail, TAA



3,840 x 2,160, High Detail, TAA

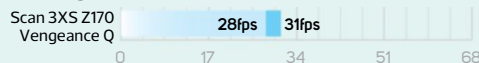


THE WITCHER 3: WILD HUNT

2,560 x 1,440, High Detail, AA on



3,840 x 2,160, High Detail, AA on



CRYSIS 3

2,560 x 1,440, Very High Detail, 0x AA



3,840 x 2,160, Very High Detail, 0x AA



Minimum Average

VERDICT








Near-silent operation in every situation and equipped with enough power to blast through games – this is the best quiet gaming PC we've seen.

Elite

Our choice of the best hardware available

Build a home theatre PC

The parts you'll need to build an affordable, home theatre PC that's ideal for putting in the lounge and playing back all manner of video formats. This machine will handle general computing and media tasks with no trouble, and its dual-core Skylake CPU can even handle 4K video playback. Meanwhile, its super-quiet Noctua CPU cooler prevents it from making a racket.

| | NAME | SUPPLIER | FEATURED | PRICE (inc VAT) |
|---|--|--|----------------|--------------------|
|  | Lian Li PC-Q09FNB with 300W FSP SFX PSU | www.overclockers.co.uk | Issue 149, p92 | £110 |
|  | Intel Core i3-6100T | www.overclockers.co.uk | Issue 149, p92 | £96 |
|  | Asus H110i-Plus D3 | www.scan.co.uk | Issue 149, p92 | £57 |
|  | 8GB Corsair 2133MHz Vengeance LP DDR3 (CML8GX3M2A2133C11B) | www.scan.co.uk | Issue 149, p92 | £45 |
|  | Noctua L9i | www.scan.co.uk | Issue 149, p93 | £32 |
|  | Samsung SN-208FB | www.scan.co.uk | Issue 149, p93 | £13 |
|  | Seagate Barracuda 2TB ST2000DM001 | www.scan.co.uk | Issue 104, p75 | £55 |
|  | Crucial 250GB BX100 | www.scan.co.uk | Issue 144, p84 | £63 |
|  | Logitech K400 Plus | www.dabs.com | Issue 149, p93 | £31 |
|  | Microsoft Windows 10 Home Retail USB drive | www.scan.co.uk | Issue 146, p17 | £90 |
| | | | TOTAL | £594 |

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ROG MAXIMUS VIII EXTREME / ASSEMBLY










**BREAK
THE RULES**

ASUS No.1 Gaming Brand Worldwide



Build a budget gaming PC

The parts you'll need to build a budget machine capable of playing the latest games at maximum settings on a 1080p monitor, and even some games at 2,560 x 1,440. The machine has a discrete graphics card, a Skylake dual-core CPU and DDR4 memory. Meanwhile, the ASRock Extreme4 motherboard enables base clock overclocking via a BIOS update.

| | NAME | SUPPLIER | FEATURED | PRICE (inc VAT) |
|---|--|--|----------------|-----------------|
|  | NZXT S340 | www.overclockers.co.uk | Issue 137, p54 | £60 |
|  | ASRock Z170 Extreme4 UPDATED | www.overclockers.co.uk | Issue 151, p84 | £106 |
|  | Intel Core i3-6100 UPDATED | www.scan.co.uk | Issue 151, p18 | £93 |
|  | 8GB (2 x 4GB) Corsair Vengeance LPX 2400MHz (CMK8GX4M2A2400C16) UPDATED | www.scan.co.uk | Issue 151, p83 | £41 |
|  | Asus Radeon R9 380 Strix 2GB | www.ebuyer.com | Issue 150, p48 | £162 |
|  | 250GB Crucial BX100 | www.scan.co.uk | Issue 144, p84 | £63 |
|  | SilverStone Argon AR01 | www.scan.co.uk | Issue 132, p57 | £25 |
|  | EVGA SuperNova GS 550W | www.dabs.com | Issue 146, p50 | £66 |
|  | Seagate Barracuda 2TB ST2000DM001 | www.scan.co.uk | Issue 104, p75 | £55 |
|  | Microsoft Windows 10 Home Retail USB drive | www.scan.co.uk | Issue 146, p17 | £90 |
| | | | TOTAL | £761 |

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ROG MAXIMUS VIII FORMULA Z170 GAMING MOTHERBOARD

PERFECT YOUR BUILD
FROM **COOLING** TO **COLOUR**











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Build a mid-range PC

Work PC

The parts you'll need to build a solid quad-core PC with plenty of upgrade potential. This kit list gives you an all-in-one liquid cooler and a K-series Core i5 Skylake CPU, meaning you can overclock it and get some serious processing power. We've managed to get the Core i5-6600K Skylake CPU up to 4.6GHz, so it has some great performance potential. Also included is a solid EVGA PSU, a 500GB SSD and 8GB of high-speed DDR4 memory. The core configuration assumes you won't be doing any serious gaming, however, and it relies on Intel's integrated graphics.

| | NAME | SUPPLIER | FEATURED | PRICE (inc VAT) |
|---|--|--|----------------|-----------------|
|  | NZXT Phantom 530 | www.overclockers.co.uk | Issue 127, p44 | £98 |
|  | Asus Maximus VIII Ranger | www.scan.co.uk | Issue 147, p44 | £145 |
|  | Intel Core i5-6600K | www.scan.co.uk | Issue 145, p17 | £195 |
|  | 8GB Corsair Vengeance LPX 2666MHz DDR4 (CMK8GX4M2A2666C16) | www.scan.co.uk | Issue 145, p24 | £48 |
|  | NZXT Kraken X41 | www.overclockers.co.uk | Issue 138, p57 | £75 |
|  | EVGA SuperNova GS 550W | www.dabs.com | Issue 146, p50 | £66 |
|  | Seagate Barracuda 2TB ST2000DM001 | www.scan.co.uk | Issue 104, p75 | £55 |
|  | Lite-On IHAS124-14 | www.dabs.com | Issue 99, p108 | £10 |
|  | Crucial BX100 500GB | www.ebuyer.com | Issue 141, p43 | £128 |
|  | Microsoft Windows 10 Home Retail USB drive | www.scan.co.uk | Issue 146, p17 | £90 |
| | | | TOTAL | £910 |

Gaming PC

The graphics card you'll need to play current games at their maximum settings at 1080p and 2,560 x 1,440.

| | NAME | SUPPLIER | FEATURED | PRICE (inc VAT) |
|---|--|--|----------------|-----------------|
|  | 1,920 x 1,080 Asus Radeon R9 380 Strix 2GB | www.ebuyer.com | Issue 150, p48 | £162 |
|  | 2,560 x 1,440 Asus Strix GTX 970 | www.ebuyer.com | Issue 150, p39 | £265 |



IN SEARCH OF INCREDIBLE




ROG MAXIMUS VIII GENE GAMING MOTHERBOARD

BEST GAMING PERFORMANCE

ASUS No.1 Gaming Brand Worldwide














Build a performance PC

Work PC

The parts you'll need to build a high-quality, fast PC that's ideal for multi-threaded workloads. This kit list features a high-quality, well-built case, a feature-rich motherboard and an Intel Skylake Core i7-6700K CPU. This processor's support for Hyper-Threading splits the resources of the CPU's four physical cores into a further four virtual cores, meaning it can effectively handle eight threads at once. There's also a solid Corsair 750W PSU, giving you plenty of headroom for overclocking and adding another GPU, 16GB of DDR4 memory, a high-speed M.2 SSD and an all-in-one liquid cooler.

| | NAME | SUPPLIER | FEATURED | PRICE (inc VAT) |
|---|--|--|----------------|-----------------|
|  | Cooler Master Cosmos SE | www.cclonline.com | Issue 144, p41 | £147 |
|  | Asus Maximus VIII Hero | www.overclockers.co.uk | Issue 146, p20 | £175 |
|  | Intel Core i7-6700K | www.scan.co.uk | Issue 145, p17 | £289 |
|  | 16GB Corsair Vengeance LPX 2666MHz DDR4 (CMK16GX4M2A2666C16) | www.scan.co.uk | Issue 145, p24 | £84 |
|  | NZXT Kraken X41 | www.overclockers.co.uk | Issue 138, p57 | £75 |
|  | Corsair RM750i | www.scan.co.uk | Issue 146, p55 | £104 |
|  | Seagate Barracuda 2TB ST2000DM001 | www.scan.co.uk | Issue 104, p75 | £55 |
|  | Samsung SSD 950 Pro 256GB | www.ebuyer.com | Issue 149, p48 | £146 |
|  | Microsoft Windows 10 Home Retail USB drive | www.scan.co.uk | Issue 146, p17 | £90 |
| | | | TOTAL | £1,165 |

Gaming PC

The graphics card you'll need to play current games at their maximum settings at 2,560 x 1,440 and beyond.

| | NAME | SUPPLIER | FEATURED | PRICE (inc VAT) |
|---|---|--|----------------|-----------------|
|  | 2,560 x 1,440 Asus Strix GTX 970 | www.ebuyer.com | Issue 150, p39 | £265 |
|  | 4K 2 x Nvidia GeForce GTX 970 4GB | www.ebuyer.com | Issue 140, p50 | £530 |

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ROG MAXIMUS VIII HERO GAMING MOTHERBOARD

ACCEPT ALL CHALLENGES

ASUS No.1 Gaming Brand Worldwide














16 Media Awards
and counting



Build a high-end 6-core PC


Multi-threaded PC

The parts you'll need to build a PC with serious power in multi-threaded software, such as 3D rendering apps, video editing programs and optimised distributed computing software. The kit list features a 6-core LGA2011-v3 CPU, which is overclockable using the motherboard and top-end cooler listed. Also supplied is 16GB of RAM, a super-fast M.2 SSD, 1TB of extra solid state storage and a 1.2kW PSU, providing loads of headroom for adding multiple GPUs.

| | NAME | SUPPLIER | FEATURED | PRICE (inc VAT) |
|---|--|--|----------------|-----------------|
|  | Phanteks Enthoo Luxe | www.eclipsecomputers.com | Issue 144, p53 | £117 |
|  | Asus X99 Deluxe | www.overclockers.co.uk | Issue 136, p20 | £320 |
|  | Intel Core i7-5820K | www.scan.co.uk | Issue 134, p43 | £319 |
|  | Asus Radeon R9 380 Strix 2GB | www.ebuyer.com | Issue 150, p48 | £162 |
|  | 16GB Corsair Vengeance LPX 2666MHz DDR4 (CMK16GX4M4A2666C16) | www.scan.co.uk | Issue 136, p14 | £97 |
|  | EKWB EK-Predator 240 | www.scan.co.uk | Issue 148, p30 | £160 |
|  | Corsair Professional Series AX1200i | www.scan.co.uk | Issue 111, p40 | £275 |
|  | Samsung SSD 950 Pro 512GB | www.dabs.com | Issue 149, p48 | £260 |
|  | Samsung 850 Evo 1TB | www.cclonline.com | Issue 141, p51 | £252 |
|  | Lite-On IHAS124-14 | www.dabs.com | Issue 99, p108 | £10 |
|  | Microsoft Windows 10 Home Retail USB drive | www.scan.co.uk | Issue 146, p17 | £90 |
| | | | TOTAL | £2,062 |

4K gaming PC

This LGA2011-v3 system can support multiple graphics cards over 28 PCI-E 3 lanes, making it an ideal foundation for high-resolution PC gaming, replacing the graphics card listed above with two high-spec cards.










| | NAME | SUPPLIER | FEATURED | PRICE (inc VAT) |
|---|---|--|----------------|-----------------|
|  | 4K 2 x Nvidia GeForce GTX 970 4GB | www.ebuyer.com | Issue 140, p50 | £530 |
| | | | TOTAL | £2,430 |



Build a mini PC

Core components

The parts you'll need to build either PC. This kit list gives you a solid PSU, 16GB of RAM, an overclockable Skylake CPU, an all-in-one liquid cooler and Windows 10 Home 64-bit. Also included is a short-PCB graphics card that can play current games at their maximum settings at 2,560 x 1,440, and a high-speed 256GB M.2 SSD.

| | NAME | SUPPLIER | FEATURED | PRICE (inc VAT) |
|---|--|-------------------|----------------|-----------------|
|  | Intel Core i7-6700K | www.scan.co.uk | Issue 147, p84 | £289 |
|  | 16GB (2 x 8GB) Corsair Vengeance LPX 2666MHz | www.scan.co.uk | Issue 147, p84 | £84 |
|  | Corsair H80i GT | www.scan.co.uk | Issue 147, p84 | £80 |
|  | Asus GeForce GTX 970 DirectCU Mini | www.cclonline.com | Issue 150, p38 | £267 |
|  | Samsung SSD 950 Pro 256GB | www.ebuyer.com | Issue 149, p48 | £146 |
|  | Seagate Barracuda 2TB ST2000DM001 | www.scan.co.uk | Issue 104, p75 | £55 |
|  | Lite-On IHAS124-14 | www.dabs.com | Issue 99, p108 | £10 |
|  | EVGA SuperNova GS 550W | www.dabs.com | Issue 146, p50 | £66 |
|  | Microsoft Windows 10 Home Retail USB drive | www.scan.co.uk | Issue 146, p17 | £90 |

Mini-ITX PC

The parts you'll need to build a pint-sized powerhouse.

| | NAME | SUPPLIER | FEATURED | PRICE (inc VAT) |
|---|-----------------------|--------------------------|----------------|-----------------|
|  | Corsair Obsidian 250D | www.scan.co.uk | Issue 136, p41 | £80 |
|  | Asus Z170i Pro Gaming | www.eclipsecomputers.com | Issue 147, p26 | £124 |
| | | | TOTAL | £1,291 |

Micro-ATX PC

The parts you'll need to build a mini PC that doesn't take up as much room as a full-sized desktop.

| | NAME | SUPPLIER | FEATURED | PRICE (inc VAT) |
|---|----------------------------|--------------------------|----------------|-----------------|
|  | Fractal Design Arc Mini R2 | www.scan.co.uk | Issue 127, p46 | £67 |
|  | Asus Maximus VIII Gene | www.eclipsecomputers.com | Issue 147, p42 | £168 |
| | | | TOTAL | £1,322 |

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NVIDIA











STRIX-GTX970-DC20C-4GD5 GAMING GRAPHICS

Unleash your
gaming instincts






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Cases

| | TYPE | NAME | SUPPLIER | FEATURED | PRICE (inc VAT) |
|---|-------------------------------|----------------------------|--|----------------|-----------------|
|  | Budget ATX | NZXT S340 | www.overclockers.co.uk | Issue 137, p54 | £60 |
|  | Sub-£100 ATX quiet | Fractal Design Define R5 | www.scan.co.uk | Issue 137, p20 | £83 |
|  | Sub-£100 ATX performance | NZXT Phantom 530 | www.overclockers.co.uk | Issue 127, p44 | £98 |
|  | Sub-£150 full-sized ATX quiet | Nanoxia Deep Silence 5 | www.quietpc.com | Issue 144, p50 | £113 |
|  | Sub-£150 full-sized ATX | Phanteks Enthoo Luxe | www.eclipsecomputers.com | Issue 144, p53 | £117 |
|  | Sub-£150 mid-size ATX | Cooler Master Cosmos SE | www.cclonline.com | Issue 144, p41 | £147 |
|  | Mini-ITX tower | Corsair Obsidian 250D | www.scan.co.uk | Issue 136, p41 | £80 |
|  | Mini-ITX cube | Fractal Core 500 | www.scan.co.uk | Issue 150, p20 | £50 |
|  | Micro-ATX | Fractal Design Arc Mini R2 | www.scan.co.uk | Issue 127, p46 | £67 |
|  | Water-cooling micro-ATX | Parvum Systems S2.0 | www.overclockers.co.uk | Issue 129, p22 | £140 |

Graphics cards

| | TYPE | NAME | SUPPLIER | FEATURED | PRICE (inc VAT) |
|---|----------------------------|---|--|----------------|-----------------|
|  | 1,920 x 1,080 gaming | Asus Radeon R9 380 Strix 2GB | www.ebuyer.com | Issue 150, p48 | £162 |
|  | 2,560 x 1,440 gaming | Asus Strix GTX 970 | www.ebuyer.com | Issue 150, p39 | £265 |
|  | High-end single-GPU gaming | EVGA GeForce GTX 980 Ti Classified ACX 2.0+ | www.scan.co.uk | Issue 147, p24 | £570 |
|  | 4K gaming | 2 x Nvidia GeForce GTX 970 4GB | www.ebuyer.com | Issue 140, p49 | £530 |
|  | Mini-ITX | Asus GeForce GTX 970 DirectCU Mini | www.cclonline.com | Issue 150, p38 | £267 |

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STRIX
Unleash Your Gaming Instincts




STRIX GTX 980 TI-DC30C-6GD5 GAMING GRAPHICS

**30% COOLER.
ODB GAMING.**



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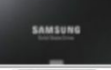


Power supplies

| | TYPE | NAME | SUPPLIER | FEATURED | PRICE (inc VAT) |
|---|----------------|-------------------------------------|------------------------|----------------|-----------------|
|  | Mid-range 550W | EVGA SuperNova GS 550W | www.dabs.com | Issue 146, p50 | £66 |
|  | High-end 550W | Super Flower Leadex Platinum 550W | www.overclockers.co.uk | Issue 146, p52 | £80 |
|  | Mid-range 750W | Corsair RM750i | www.scan.co.uk | Issue 146, p55 | £104 |
|  | High-end 1.2kW | Corsair Professional Series AX1200i | www.scan.co.uk | Issue 111, p40 | £275 |

Networking

| | TYPE | NAME | SUPPLIER | FEATURED | PRICE (inc VAT) |
|---|---------------|---------------|-------------------|----------------|-----------------|
|  | Router | Asus RT-AC68U | www.cclonline.com | Issue 128, p88 | £140 |
|  | Wi-Fi adaptor | Asus PCE-AC68 | www.dabs.com | Issue 128, p88 | £70 |

Storage

| | TYPE | NAME | SUPPLIER | FEATURED | PRICE (inc VAT) |
|---|----------------------|-----------------------------------|-------------------|----------------|-----------------|
|  | Hard disk | Seagate Barracuda 2TB ST2000DM001 | www.scan.co.uk | Issue 104, p75 | £55 |
|  | 250GB SSD | Crucial BX100 250GB | www.scan.co.uk | Issue 141, p43 | £63 |
|  | 500GB SSD | Crucial BX100 500GB | www.ebuyer.com | Issue 141, p43 | £128 |
|  | 1TB SSD | Samsung 850 Evo 1TB | www.cclonline.com | Issue 141, p51 | £252 |
|  | High-performance SSD | Samsung SSD 950 Pro 512GB | www.dabs.com | Issue 149, p48 | £260 |
|  | NAS box | Synology DS215J | www.cclonline.com | Issue 138, p17 | £134 |

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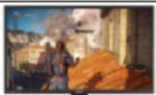




STRIX-R9380X-OC4G GAMING GRAPHICS

ASUS STRIX R9 380X delivers pumped gaming performance and extreme reliability.









ASUS No.1 Gaming Brand Worldwide



Monitors

| | TYPE | NAME | SUPPLIER | FEATURED | PRICE (inc VAT) |
|--|------------------------|--|--------------------------|----------------|-----------------|
|  | 24in monitor | Dell U2414H | www.overclockers.co.uk | Issue 129, p43 | £189 |
|  | 27in 4K monitor | Asus PB279Q UPDATED | www.overclockers.co.uk | Issue 151, p40 | £540 |
|  | 27in G-Sync monitor | Asus ROG Swift PG278Q | www.eclipsecomputers.com | Issue 143, p44 | £552 |
|  | 27in FreeSync monitor | BenQ XL2730Z | www.overclockers.co.uk | Issue 143, p46 | £456 |
|  | 27in 4K G-Sync monitor | Asus ROG Swift PG27AQ | www.scan.co.uk | Issue 151, p42 | £716 |
|  | 27in 5K monitor | Dell UltraSharp UP2715K UPDATED | www.scan.co.uk | Issue 151, p44 | £959 |

Peripherals

| | TYPE | NAME | SUPPLIER | FEATURED | PRICE (inc VAT) |
|---|----------------------------|--|------------------------|----------------|-----------------|
|  | Mechanical gaming keyboard | CM Storm Trigger-Z | www.amazon.co.uk | Issue 139, p44 | £105 |
|  | Budget gaming mouse | Cooler Master Xornet II | www.cclonline.com | Issue 149, p28 | £21 |
|  | Gaming mouse | Logitech G402 Hyperion Fury | www.currys.co.uk | Issue 139, p53 | £40 |
|  | Ambidextrous mouse | Roccat Kova | www.cclonline.com | Issue 150, p28 | £50 |
|  | MMO gaming mouse | Corsair Scimitar RGB | www.scan.co.uk | Issue 150, p17 | £70 |
|  | Wireless gaming mouse | SteelSeries Sensei Wireless | www.overclockers.co.uk | Issue 139, p61 | £100 |
|  | Flight stick | Saitek X-55 Rhino H.O.T.A.S. | www.overclockers.co.uk | Issue 131, p29 | £170 |
|  | Steering wheel and pedals | Thrustmaster TX Ferrari 458 Italia Edition | www.overclockers.co.uk | Issue 137, p32 | £230 |

ASUS
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Z170I PRO GAMING MINI-ITX MOTHERBOARD

**MINI SIZE.
MAXIMUM WINS.**








ASUS No.1 Gaming Brand Worldwide



Audio

| | TYPE | NAME | SUPPLIER | FEATURED | PRICE (inc VAT) |
|---|------------------------|------------------------|------------------------|----------------|-----------------|
|  | PCI-E sound card | Asus Strix Raid DLX | www.scan.co.uk | Issue 148, p28 | £146 |
|  | 2.1 speakers | Acoustic Energy Aego M | www.amazon.co.uk | Issue 142, p52 | £150 |
|  | Soundbar | Razer Leviathan | www.overclockers.co.uk | Issue 142, p57 | £165 |
|  | Headset | HyperX Cloud II | www.scan.co.uk | Issue 142, p46 | £73 |
|  | Surround-sound headset | Asus Strix 7.1 | www.dabs.com | Issue 142, p43 | £147 |

Systems

| | TYPE | NAME | SUPPLIER | FEATURED | PRICE (inc VAT) |
|---|----------------------|--|-----------------------------|----------------|-----------------|
|  | Quiet gaming PC | Scan 3XS Z170 Vengeance UPDATED | www.scan.co.uk | Issue 151, p60 | £1,500 |
|  | Dream PC | Scan 3XS Barracuda | www.scan.co.uk | Issue 145, p58 | c.£9,499 |
|  | Sub-£2,000 gaming PC | CyberPower Infinity X77 Deluxe | www.cyberpower system.co.uk | Issue 150, p56 | £1,999 |
|  | Skylake PC | Scan 3XS Z170 Vengeance | www.scan.co.uk | Issue 145, p66 | c. £1,449 |
|  | Mini-ITX gaming PC | Chillblast Fusion Fury Nano | www.chillblast.co.uk | Issue 147, p56 | c.£1,619 |
|  | Premium PC | Scan 3XS X99 Carbon Extreme SLI | www.scan.co.uk | Issue 148, p62 | c.£4,799 |
|  | Water-cooled PC | Overclockers Infin8 Toxicity | www.overclockers.co.uk | Issue 150, p58 | £3,414 |

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Games



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Inverse look p73 / Helldivers p74 / Homeworld: Deserts of Kharak p76 /
Dragon's Dogma: Dark Arisen p76 / The Beginner's Guide p78 / The engine room – Divinity p80



RICK LANE / INVERSE LOOK

JOLLY COOPERATION

Rick Lane considers what makes a great cooperative game

Almost any game can be improved by adding a cooperative mode. There's something about playing a game with a friend, regardless of its genre or structure, that simply makes it more fun. It's a universal recipe for japes and in-jokes, turning serious games into comedies and comedy games into absolute riots.

Yet while cooperative modes almost naturally make most games more enjoyable, the addition of an extra player doesn't necessarily result in an exceptional cooperative game. Indeed, after the release of Valve's superb *Left 4 Dead*, the explosive trend of forcing a cooperative mode into almost every game put me off cooperative gaming for a long time.

Over Christmas, however, I found myself drawn back into cooperative gaming by a couple of fantastic examples, which led me to ponder what made these games different, and what's been missing up to this point.

The two games in question are *Helldivers* and *Keep Talking and Nobody Explodes*. You can find out all about *Helldivers* in our review on p74, while *Keep Talking and Nobody Explodes* involves defusing a bomb – one player sits at the computer in front of a virtual bomb; the other faces away from the screen with an instruction manual. The player at the computer must describe the bomb to the manual reader, and the manual reader offers instructions on how to defuse it before the time runs out.

The biggest issue with many cooperative games is that they're essentially single-player experiences with a few cooperative actions. Games such as *Borderlands* and *Diablo* aren't necessarily bad, but they essentially involve multiple players joining the same single-player experience.

The game may spawn more enemies or increase the difficulty with more players, but interactively, it's the same as the single-player game, aside from moments where the game forces

cooperation, such as players working together to open a door. What makes *Helldivers* and *Keep Talking* successful as cooperative games is that the cooperation is persistent. They give players a specific problem or series of problems to solve, and the whole game is dedicated to resolving them.

In *Keep Talking* and *Nobody Explodes*, for example, both players perform completely separate actions. The cooperation element emerges from the time pressure of having to defuse the bomb, and the complexity of interaction required. Both these roles are equally and persistently important – there's no 'downtime' for either player.

Helldivers also minimises enforced cooperation – there's no moment when all players need to simultaneously pull levers to open doors, for example. Instead, much like *Left 4 Dead*, it attempts to separate the team using clever enemy spawns, but then it also induces panic, so the natural response of players is to try to stick together. *Helldivers* pitches the

game itself as the opponent, so players feel inclined to work as a team to defeat it.

Another reason why both games are such great cooperative experiences is that they can be played locally – a tragically rare treat on the PC. Alongside not requiring all your friends to own gaming PCs, local co-op also enables a more social dynamic, or for you to enjoy a quick half-hour with a flatmate or partner.

As more friends, couples and families grow up with games as a persistent part of their lives, to be able to play games while you're physically together is an important factor that's frequently overlooked by developers.

It creates a unique feeling that simply can't be replaced by remote interactions through online gaming or social media, and I believe it's going to be an increasingly vital component of future cooperative games. **EPG**

They're essentially
single-player
experiences with a few
cooperative actions

Helldivers / £15 inc VAT



DEVELOPER Arrowhead Game Studios / PUBLISHER PlayStation Mobile Inc / WEBSITE <http://arrowheadgamestudios.com/games/helldivers>



Helldivers is the finest cooperative game since Left 4 Dead, a frenzied team-based shooter where, if your enemies don't get you, you'll be got accidentally by your friends instead. It's Starship Troopers meets Keystone Cops, a blend of frenetic action, tongue-in-cheek satire and slapstick comedy. It's also fearsomely challenging and richly rewarding, taking no prisoners but recognising talent and teamwork.

Arrowhead Studios' sci-fi shenanigans place you in the steel-plated boots of a Helldiver, one of thousands of identikit interstellar soldiers tasked with bringing 'democracy' to the alien enemies of Super Earth in a vast galactic war. The Helldivers' approach to spreading government via popular consensus is certainly unique – they land on an alien planet by orbital drop pod, then shoot or explode anything that comes within a hundred feet of their position until the planet is conquered.

In practice, there's a lot more to playing Helldivers. Alien planets are divided into missions, which in turn comprise several objectives, which are randomly generated each time. To complete a mission, players must drop into it at a point they select, complete all the objectives, then activate an extraction beacon and fend off waves of enemies until a shuttle arrives to collect them.

While up to four players can work together on any given Helldiver mission, they're always massively outnumbered by the alien presence, be it Starship Trooper-inspired hordes of insects, creepy cyborgs or Protoss-like hyper-advanced beings with smooth curves and energy-based weaponry. To make matters worse, each Helldiver drops into play with only two grenades and a small amount of ammo to combat these overwhelming forces.

To stand any chance of survival, the Helldivers must employ their Stratagems – special abilities summoned from orbit by inputting a unique code based on the directional keys. They range from simple ammo drops to automated minigun turrets, devastating artillery barrages, more powerful weapons and even vehicles such as walking mechs or armoured personnel carriers.

The Helldiver arsenal is mightily impressive, with 51 Stratagems and around 20 standard weapons that can be unlocked by conquering planets. But what makes Helldivers such a brilliant, unpredictable cooperative experience isn't the Stratagems'

strengths, but their weaknesses. The automated turrets are enormously powerful, but they shoot at any enemy that comes into range, whether there's a Helldiver stood in the way or not. The mech offers fantastic protection, but it's slow to turn and must be exited to complete objectives. The APC gets you around maps quickly and can run over enemies, but it will run you over as well if you're not careful when disembarking. Imagine if the US military was supplied by ACME from Looney Tunes, and you have some idea of how the Helldivers operate.

This notion of the Helldivers being their own worst enemy runs through the whole game. Friendly fire is always on, so it's easy to shoot your teammates, and difficult to get back up unless aided by a friend. If a Helldiver dies, they must be called back into play using a Stratagem,

but the descending hellpod then kills anything on which it lands, including the Helldiver who summoned it if they're not careful. Even the escape shuttle can squash you flat if you're a little too keen to get off the planet.

Provided the team is organised and doesn't panic, these accidents are easily avoided but, of course, the game tries to make you panic all the time. Each map is peppered by enemy patrols; if they spot you before you take them out, they call in a much larger assault on your position. Your adversaries don't simply charge in from the sides either. They emerge from the ground, descend from the sky or teleport into the battlefield, often right in the middle of your ranks. Focusing on these enemies forces players to neglect new patrols, who call in more enemies, so the situation spirals out of control faster than a jet-powered dreidel.

Like the splendid Left 4 Dead, Helldivers doesn't encourage teamwork by forcing interactions with other players, but by constantly trying to pull the team apart. The bonds of comradeship are forged in the fire of mayhem and combat, which is spectacular. Although it's a top-down shooter, the game's weapons carry the heft and force of the very best first person shooters.

The mech in particular is a stomping delight, its underslung minigun shredding opponents like a metal guitarist. Meanwhile, higher-level Stratagems include orbital rail-cannon strikes and devastating cruise missiles – thunderous treats delivered by Helldiver command. Considered as a pure action game, Helldivers is phenomenally entertaining.

There are a few issues though. It's possible to play the game in single-player mode, and doing so poses a formidable tactical challenge.

However, the pacing suffers greatly, and you lose much of the incidental hilarity that's key to the overall experience. There's also a meta-game component where your efforts in individual missions contribute to the broader galactic war, with fronts changing dynamically depending on player actions. However, unless you happen to be present when a war is won or lost, the impact of this component barely registers, save as a slightly irksome delay between missions as the game uploads the information to the server.

Yet even this flaw makes sense given Helldivers' tone and context. What's perhaps most pleasing about Helldivers is how all its parts play into its tongue-in-cheek send-up of the righteousness of western warfare. The Helldivers present themselves as ferocious, chest-beating purveyors of freedom through force, screaming 'How about a nice cup of Liber-tea?' as they unload a stream of bullets into the faces of baffled alien spiders. But the reality is that they're barely competent cannon fodder fighting a morally outrageous conflict. Most missions are barely averted calamities, in which the Helldivers' technological bombast is as much a hindrance as a help.

It's hardly subtle satire, but the way in which it's conveyed both systemically and aesthetically is ingenious. Helldivers is one of those rare games where everything fits together beautifully, resulting in a thrilling and volatile blend of ideas.

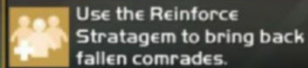
RICK LANE

OVERALL SCORE

90%

/ VERDICT

Whether played locally with a partner, in a group with friends or online, Helldivers is cooperative heaven, and a snappy satire too.



Homeworld: Deserts of Kharak / £30 inc VAT



DEVELOPER Blackbird Interactive / PUBLISHER Gearbox Software / WEBSITE www.desertsofkharak.com

OVERALL SCORE

82%

/ VERDICT

Spectacular and thrilling, Deserts of Kharak is a worthy addition to the Homeworld series, even if it doesn't demonstrate any major new ideas.

Initially conceived as a spiritual successor to the Homeworld series of RTS games, Blackbird Interactive's game, *Hardware: Shipbreakers*, was given the nod to use the official Homeworld title by Gearbox Software last year. This move resulted in its re-emergence as *Homeworld: Deserts of Kharak*, a prequel that explores the lead-up to the events depicted in the first game.

The game charts the expedition of the Coalition Carrier Kapisi to locate the Primary Anomaly, believed to be able to save the dying planet of Kharak from its ever-expanding deserts. The Kapisi is the terrestrial equivalent of Homeworld's mothership, a mobile base

of operations that can produce units, research new units and fight in battles itself.

Deserts of Kharak controls like the original Homeworld too. The splendidly designed units are based on those from the 1999 RTS, ranging from lightly armoured dune buggies that swarm enemies, to hulking cruisers that move with a glacial inevitability matched by the power of their arsenal. That said, Deserts of Kharak offers greater tactical variety than its parent game. Higher terrain provides a damage boost, while deployable aircraft sorties and a smattering of super-weapons enable effective counter-tactics to the 'build n' swarm' strategy that dominates most RTS games.



Dragon's Dogma: Dark Arisen / £24 inc VAT

DEVELOPER Capcom / PUBLISHER Capcom / WEBSITE www.dragonsdogma.com



Dragon's Dogma is a fascinating mixture of the brilliant and the bizarre, colliding a staunchly traditional Western fantasy aesthetic with a Japanese experiment in action role playing. The story traces a nameless hero known as the Arisen, whose heart is literally stolen by a dragon, and who must retrieve it by tracking down and killing the beast.

Despite a promising beginning and surprising conclusion, Dragon's Dogma's narrative isn't particularly strong.

Characters enounce their stilted dialogue with all the enthusiasm of Lurch from *The Addams Family*, while the plot points between the beginning and end are oddly disjointed, hinting at loose ends the developer was unable to tie up due to budget constraints.

Yet Dragon's Dogma makes up for its storytelling with an imposing fantasy world and fascinating mechanics. The mountainous realm of Gransys is wild and foreboding; its winding roads are prowled by bandits and goblins during the day, and even more dangerous creatures by night. Savvy adventurers can find shortcuts through the mountains via dark caverns and abandoned quarries, provided they can survive the attention of their denizens.

Dragon's Dogma is more about journeys, and the encounters that occur during them, than destinations. The journeys include truly epic battles with huge monsters, such as giant Cyclopes that can straddle buildings, or winged Griffins that scythe down from the skies, talons outstretched. Although these creatures lack the originality of Dark Souls' bosses, they're fearsome and wonderfully designed, requiring teamwork and tactics to defeat.

To that end, a group of pawns accompanies you on your adventures – emotionless mercenaries dedicated to aiding the Arisen. Despite their muted personalities, pawns make excellent travelling companions, memorising routes and warning you of nearby dangers. They also aid you in combat, providing support as mages or skirmishers, or attacking directly as warriors. They can pin down an enemy for you to perform a killing blow, and even clamber onto larger enemies, striking at weak points (both abilities that are also available to the player). Away from grappling, combat is slick and spectacular, although it lacks the tactile satisfaction of *The Witcher 3* or *Dark Souls*.

While there's plenty to enjoy, though, Dragon's Dogma isn't particularly accessible. Take a wrong turn in the first few hours and it can become a punishing slog from which

OVERALL SCORE

80%

/ VERDICT

Dragon's Dogma makes up for a few flaws through its originality and powerful sense of adventure.

The 14-mission campaign sees you slowly crawling through the sands, squaring off against the fearsome Gaalsian tribe, which believes that any interference with the deserts' hidden spacecraft wreckage is heresy. Plunging deep into enemy territory, the Kapisi must fend off wave after wave of attacks. Each campaign mission is carefully structured to test your tactical abilities. One sees you defending a series of dispersed wreckage scanners from Gaalsian assault. In another, you must support an allied carrier as it bears the brunt of a Gaalsian attack, before flanking the enemy and taking out two of its Carriers.

These ferociously intense battles are complemented by a story that, although lacking the emotional heft of the original Homeworld, still has superb pace and a fitting sense of foreboding. Despite being the 'bad guys', the

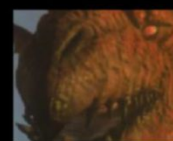


Gaalsians constantly cast knowing glances at the Coalition's lack of comprehension of the tribe's powers.

The elegant presentation and watertight systems all hark back to the original Homeworld. However, the 'shipbreaking' mechanic, whereby you break down bits of wrecks into resources, has fantastic potential, but boils down to breaking open ramshackle crates for loot. The final form of this idea is barely worthy of inclusion in the game.

Deserts of Kharak may be largely a reinvention of a 16-year-old wheel, but it's an incredibly impressive reinvention nonetheless. It's a prequel that manages to offer something different without forgetting what made the original a success, even if, ultimately, it fails to demonstrate much that's new.

RICK LANE



it's difficult to extricate yourself. All the game's menus are painfully fussy too, whether it's inventory management or skill improvement. The action also takes a downturn towards the end, forcing you to tediously revisit several locations rather than opening up new areas. Fortunately, the PC version includes the Dark Arisen expansion, providing a chunk of much-needed higher level content.

However, it's worth pushing through Dragon's Dogma's low points to savour those incredible highs, clinging on for dear life to a griffin's wing, or watching a troublesome Cyclops tumble off a cliff. Adventurous in both theme and concept, Dragon's Dogma is a worthy addition to anyone's role-playing retinue.

RICK LANE



The Beginner's Guide / £7 inc VAT

DEVELOPER Everything Unlimited Ltd / PUBLISHER Everything Unlimited Ltd / WEBSITE www.thebeginnersgui.de

Davey Wreden's follow-up to *The Stanley Parable* is a natural successor to that game's hilarious deconstruction of choice and consequence, and a fascinating departure from it. *The Beginner's Guide* presents itself as a playable documentary, exploring the short, experimental games made by a reclusive game designer who goes by the moniker Coda. However, both the origins and purpose of the game are ultimately dependent on the player's interpretation.

Starting in a game that resembles a half-finished Counter-Strike map, the player explores Coda's game design experiments sequentially; these become increasingly bizarre until, according to Wreden, Coda

abruptly ceases making games and disappears. Like *The Stanley Parable*, the experience is strung together by an unseen narrator, only this time the narrator is Wreden himself. He describes his friendship with Coda, and offers his interpretation of the designer's ideas.

You explore Coda's designs, all of which are minimalist, simplistic in interaction, and usually revolve around a gimmick. An early example is a first-person game in which you can only walk backwards, while another purports to allow players to leave 'notes' for each other to read around the level, when in actuality, all the notes are written by Coda himself.

On their own, these levels would quickly become dull, but they tick over at such a pace that they retain your interest. As the game progresses, Coda's work

becomes increasingly emotionally charged, as does Wreden's own narration. *The Beginner's Guide* is as much about Wreden's own musings on game design and his relationship with his creations as it is about the strange little worlds you're exploring. Wreden's feelings appear genuine, though, and the concluding revelation is surprising regardless of your own view of the situation.

With these types of games, there's a danger of them coming across as smug or self-indulgent, but Wreden successfully mitigates this risk with his straightforward narration and uncompromisingly critical approach to himself. The game also sports a gentle sense of humour and a flair for the dramatic, with several mightily impressive environmental reveals.

If *The Beginner's Guide* has a flaw, it's that the ingenuity of some of its ideas is rather suspect. The notion of players leaving notes in a level, for example, feels about ten years behind the times, while others, such as *The Cleaning Game*, outstay their welcome despite their brevity.

Nevertheless, *The Beginner's Guide*'s intriguing premise and fascinating meta-mystery makes it worthy of the half-evening it demands to play. Whether it's fact or fiction, it's a gripping piece of virtual storytelling, and the swift rate of ideas negates the tedium that can worm its way into similar games. It doesn't quite equal the joyous inventiveness of *The Stanley Parable*, but it comes surprisingly close, despite its markedly different tone.

RICK LANE

OVERALL SCORE

77%

/ VERDICT

Ambitious and intimate, *The Beginner's Guide* is a thought-provoking piece of ambiguous storytelling.

INDEPENDENT AND UNOFFICIAL GUIDE

MINECRAFT SECRETS & CHEATS



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The procedurally generated nature of Dragon Commander's terrain, combined with its complicated pipeline, means it lacks Original Sin's visual nuance

RICK LANE / THE ENGINE ROOM

Divinity

Rick Lane speaks to Divinity developer Larian Studios about its road to independence, and technology that emerged from this move

In 2011, Belgian developer Larian Studios decided to go independent. The creator of the long-running Divinity series of fantasy RPGs broke away from its various regional publishers, and began work on two new games; the strategy game Divinity: Dragon Commander, and the cooperative RPG Divinity: Original Sin.

Larian decided to build its own tech, referred to in-house as the Divinity Engine. 'We were using Gamebryo back then, which we'd used to ship the Dragon Knight saga in 2010,' says Swen Vincke, Larian founder and creative director. 'We'd had quite a few problems with Gamebryo – typical middleware problems. We weren't in control of the tech. Gamebryo was following

a different roadmap from where we wanted it to go, so we said, "at some point we're going to have to take our own future into our own hands and start making our own technology".'

What followed was akin to a rebirth for the studio, during which it built two conceptually diverse and creatively experimental fantasy games using an engine it was essentially making up as it went along. The end results are both worthy creations, but getting them to that stage wasn't easy.

Originally, the Divinity Engine was intended to be used solely for Original Sin, but as the people in the team began building the tech, they eventually decided to build Dragon Commander with it as well, rather than sticking with Gamebryo for one

last project as initially intended. Despite adopting the Divinity engine later than Original Sin, Dragon Commander was actually released almost a year earlier. 'For Dragon Commander, the technology was more primitive, or younger I guess, because Original Sin had more time to mature – from a technical point of view, we could call that one more challenging,' Vincke says.

To fulfil its vision for Dragon Commander, a 3D RTS in which you swoop over the battlefield atop a huge winged lizard, Larian decided to build a completely new graphics pipeline around a piece of terrain-generating middleware. The resulting megatextures were then combined with a program called Graphine, which enabled level-



The environments in Original Sin are all hand-crafted, resulting in superbly detailed, diorama-like scenes

streaming. 'That pipeline was really very complicated, requiring lots of offline rendering time. It was very hard for level designers to actually make a decent level with it,' Vincke says, adding that 'actually I think it was the worst pipeline we've ever developed'.

Despite struggling with Dragon Commander's terrain, Vincke was ultimately satisfied with the game that shipped. Moreover, the completion of Dragon Commander meant that Larian could then focus entirely on Original Sin. From a technical perspective, Original Sin already had a head start, and the top-down camera meant terrain was much less of an issue. 'In Dragon Commander, we were limited by the enormous amount of work, whereas with Original Sin, it was perfectly possible to hand-paint everything,' Vincke says. Indeed, Original Sin's environments are all hand-crafted, resulting in superbly detailed, diorama-like scenes.

Larian needed to spend less time getting the game into a functioning state, and more time on details and embellishments. Some of the most notable visual features of Original Sin are its splendid elemental effects used in magic spells, and the way in which those effects can combine to produce other effects, such as creating a steam cloud by throwing a fireball into a puddle of water.

These effects were produced using a blend of middleware and in-house tech. The visual effects, including the particle system, were created in FX Studio, while the functional side of



Original Sin sports impressive environmental effects, created in FX Studio. Fire in particular makes a dramatic change to the image

those effects were coded in what Vincke calls a dedicated surface system. 'That was custom programmed to support the game's ability to combine fire with water and ice, and all that,' he says. In Original Sin, Elemental magic can combine and cause transitions. Electricity spreads through water, fire turns water into steam clouds and so on. However, this system 'was limited by the amount of bits we reserved,' says Vincke. 'We always wanted to have more surfaces, but we couldn't back then because we were out of bits in the system, but we were able to do a lot more for Original Sin 2.'

Although Original Sin was a simpler project from a visual perspective, the game still provided

In Original Sin, Elemental magic can combine and cause transitions. Electricity spreads through water, fire turns water into steam clouds and so on



its fair share of challenges in other areas. Most significantly, Larian was aiming to create a cooperative RPG in which both players could have a significant effect on the story, but one that could also be enjoyed single-player if you wished. 'That was also not so trivial, because there weren't really any examples for us to look at,' Vincke says. 'If you look at MMOs, they use very safe mechanics in terms of how they set up the quests, which isn't the case at all in Original Sin, where one player can kill the quest giver of the other player, and it still has to make sense and work.'

The netcode also formed a departure from Larian's previous work. 'Dragon Commander was peer-to-peer, which is easy because you just need a deterministic state machine and then you don't have to worry. Original Sin, on the other hand, is a client server,' Larian took this approach so Original Sin could be expanded beyond two players. However, when handling requests for complex or nuanced calculations, such as physics, client servers can cause players to experience the game differently. 'It caused a lot of extra work,' Vincke says.

Original Sin launched to favourable reviews in June 2014, but Larian still wasn't finished with the game. Over the next year, it prepared an Enhanced Edition that included more complex visuals, a split-screen mode and it launched on multiple platforms. However, the most significant change, facilitating these more noticeable alterations, was the switch from single to multi-threading. 'What's surprising is that, despite having more effects, better graphics and so on, the Enhanced Edition runs on the lower minimum specs because it's so well optimised. It runs smoothly at 60fps on quite a lot of configurations,' says Vincke.

Four years and two games on from going independent, Larian now has a reliable homebrew engine and has commenced work on Original Sin 2 from a much stronger position than the previous titles. However, it still plans to push the Divinity Engine beyond its current capabilities. 'We're expanding pretty much every single system,' says Vincke, 'in all kinds of directions.' **OPB**



BUILD AN OVERCLOCKED SKYLAKE GAMING PC FOR £596 INC VAT

Thanks to some recent motherboard tweaks, you can now overclock a budget Skylake CPU and build a decent gaming system for under £600. Antony Leather shows you how it's done

Budget and overclocking are two words that rarely go together these days, mainly thanks to Intel killing off any significant gains that could be had from cheap CPUs by introducing unlocked K-series products such as the Core i7-6700K. Only these CPUs, with their unlocked multipliers and later base clock flexibility, can be overclocked by significant amounts, unless you opt for an aging Pentium G2358. Officially, the rest of the field – for Intel's CPUs at least – is limited to tiny base clock adjustments when it comes to overclocking.

However, late last year saw the introduction of new BIOS versions from a number of motherboard manufacturers, bringing back budget overclocking to the masses. These BIOS updates allow the base clock to be increased not by just a few megahertz but tens of megahertz, paving the way for substantial overlocks on all of Intel's Skylake non K-series CPUs. This month, we'll be building a budget system that takes full advantage of this situation, and show you how to do it.

SHOPPING LIST

CASE

Raijintek Agos / **£40 inc VAT**

SUPPLIER www.overclockers.co.uk

While the image-conscious might want to consider opting for the more expensive NZXT S340, the Raijintek Agos picked up an Approved award in our last budget case

Labs (see Issue 137, p55),

thanks to good cooling, reasonable features, a solid design and a very wallet-friendly price tag. It can accommodate water-cooling gear too, if you wanted to upgrade your system later, plus it has loads of space for storage and enough room for the largest graphics cards. It even has removable

dust filters as well. Basically, while other cases might have the edge on aesthetics, the Agos' £40 price tag means it undercuts them by a significant margin without sacrificing performance and features, making it ideal for a budget system.

ALTERNATIVE

NZXT's S340 costs around £15 more than the Agos, but looks better with its internal PSU cover inside, snazzy paint job and minimalist exterior. Unlike the Agos, it also has a side window option.

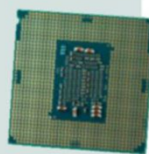


Of course, there are no guarantees when overclocking, but if you're able to spend nearly £130 on a Core i3, you may as well stump up the extra £15 and get the Core i5-6400 anyway.

Don't be tempted by the low power Core i3 chips though – they're great for HTPCs, but they have much lower multipliers, so they're hampered when it comes to base clock overclocking, and they're comparatively pricey.

ALTERNATIVE

You can also consider Core i5 Skylake CPUs if your budget will allow it, and you can use more processing cores. The Core i5-6400 has four physical cores, so it will be quicker at multi-threaded video encoding and rendering tasks and, apart from its stock frequency and the lack of an unlocked multiplier, it's identical to a much more expensive Core i5-6600K. Many reports online, albeit with more expensive motherboards, show the Core i5-6400 being overclocked past 4.4GHz using the base clock – not bad for a CPU that undercuts the Core i5-6600K by nearly £50.



CPU

Intel Core i3-6100 /

£93 inc VAT

SUPPLIER www.overclockers.co.uk

Now that Intel's whole Skylake CPU range is potentially overclockable, the Core i3-6100 (see p18) sits in the budget sweet spot. The next Core i3 steps up cost £23 and £33 more respectively, and the Core i3-6300 and Core i3-6320 only have multipliers of 38x and 39x, so they don't offer a massive leap over the i3-6100's 37x multiplier anyway.

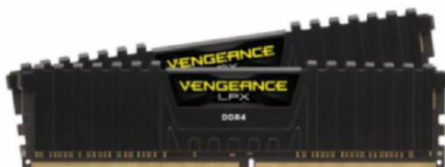
MEMORY

8GB (2 x 4GB) Corsair Vengeance LPX

2400MHz / **£41 inc VAT**

SUPPLIER www.scan.co.uk

Although tinkering with the base clock can affect memory frequency, you just need to



alter the memory clock with the motherboard's divider to stop it being overloaded, so you don't need a super-fast memory for an overclocked system. If you're on a tight budget and using a sub-£100 CPU, it makes sense to cut costs on the memory, and 8GB (made up of two 4GB modules, so you can enable dual-channel mode for more bandwidth) will be fine for gaming and everyday computing for most people.

There's a fair price difference between the slowest and fastest memory, but you don't want to go too slow – in our tests, dropping down to 2133MHz memory resulted in small performance hits across the board in comparison with our usually recommended 2666MHz frequency. However, dropping down to 2400MHz memory softens the blow to a point where the performance difference is negligible, saving you a tenner in the process.

GRAPHICS CARD

Asus Radeon R9 380

Strix 2GB / **£162 inc VAT**

SUPPLIER www.ebuyer.com

AMD's GPUs might still be based on the company's aging GCN architecture, but some tweaks and price drops have made the company's Radeon R9 380 a cracking offering in the sub-£200 bracket, offering more bang for your buck than Nvidia's GTX 960. There are some 4GB versions floating around, such as Sapphires excellent R9 380 Nitro Backplate 4GB (see Issue 150, p52), but the extra RAM only comes into play in certain games. There are plenty of 2GB models as well, but our favourite is the Asus R9 380 Strix 2GB (see Issue 150, p48). It isn't much faster than a stock card and there are faster pre-overclocked models out there, but its fantastic cooler is exceptionally quiet and effective to boot.



ALTERNATIVE

If you need a little more performance, especially in Fallout 4, 4GB versions of the R9 380 are worth a look. However, if you'll be gaming at 2,560 x 1,440 and above, you'll need to opt for something more potent. Nvidia's GeForce GTX 970 is our 2,560 x 1,440 graphics card of choice and, once again, it's the Asus Strix version that we recommend, which costs around £260 inc VAT.



MOTHERBOARD

ASRock Z170 Extreme4 / **£106 inc VAT**

SUPPLIER www.overclockers.co.uk

Our testing showed that there's a noticeable difference in overclocking ability between some boards. The ASRock Z170 Extreme4 managed to achieve a base clock of 119MHz with our particular Core i3-6100, but the noticeably cheaper MSI Z170-A Pro could only stretch to 113MHz with the same CPU. As such, we think the ASRock board is worth the extra outlay if you want to get the most from your Core i3-6100. It also has a plethora of overclocking and testing tools, looks snazzy and sports USB 3.1 Type-A and Type-C ports.

ALTERNATIVE

If you want to trim an extra £20 off the system price for an even more wallet-friendly total, the MSI Z170-A Pro still offered the ability to get an extra 500MHz out of our Core i3-6100, and would provide a good base for a more expensive CPU in the future. It also has an M.2 port and an excellent EFI.



CPU COOLER

SilverStone Argon AR01 / **£25 inc VAT**

SUPPLIER www.scan.co.uk

One issue with base clock overclocking is that it makes it impossible to read the CPU temperature using the usual software.

However, as even our Core i7-6700K can be tamed with good air coolers at 4.6GHz, with higher vcores than we're using for our Core i3 chip, the settings we've used in this guide with our Core i3-6100 only require a good air cooler to push it to the max. SilverStone's Argon AR01 is quiet, easy to install, compact and performs very well even against larger coolers. It's more than up to the task and it only costs £25 inc too.



ALTERNATIVE

There's little need to opt for a more potent cooler than the Argon AR01 when dealing with a Core i3 chip. However, an all-in-one liquid cooler will stand you in good stead if you intend to drop a quad-core CPU into the system in the future. NZXT's Kraken X41 is our current all-in-one liquid cooler of choice.

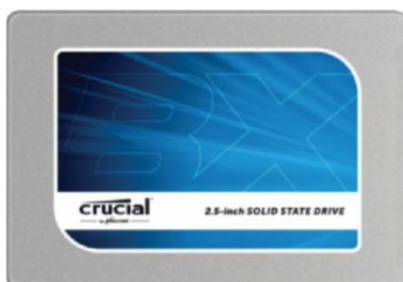


STORAGE

Crucial 250GB BX100 / **£63 inc VAT**

SUPPLIER www.scan.co.uk

Solid state drives are now easily affordable, even when you have a tight budget. In terms of capacity, 128GB isn't really enough to be



comfortable, especially when modern games such as GTA V consume half this space on their own. However, a 250GB Crucial BX100 drive will offer enough space for Windows, a few games and a fair bit of data. As a result, if you're able to keep a lean system, you can ditch a hard disk entirely, saving around £50.

ALTERNATIVE

If you need a little extra space, perhaps for media storage, a 2TB Seagate Barracuda hard drive will set you back around £50. Alternatively, the 500GB version of Crucial's BX100 currently retails for £127, meaning you'd have to pay an extra £64 to double your storage space over the 250GB version.



PSU

EVGA SuperNova GS 550W / **£66 inc VAT**

SUPPLIER www.dabs.com

Modern Intel systems are very power-frugal and, although AMD's GPUs require a fair amount of power, the R9 380 is much less energy-hungry than its bigger siblings. As we're using this GPU with a simple Core i3 CPU, a 500W PSU will offer all the power we need. We've chosen EVGA's SuperNova GS 550W, as it's stable, quiet, 100 per cent modular and offers enough power to grow, perhaps by upgrading to a quad-core CPU later, providing a degree of future-proofing.

TOTAL PRICE:
£596 inc VAT

BUILDING THE PC

01 TEST PARTS OUTSIDE CHASSIS

In order to avoid having to dismantle the system once you've already built it, due to a dead-on-arrival item, test the components outside the case first. Such occurrences are rare, but the test takes ten minutes and you can just sit the bare system on a non-conductive surface, such as your motherboard box, a wooden desk or a sheet of cardboard. The ASRock Z170 Extreme4 is ideal for testing in this way, as it has on-board power and reset buttons as well as an LED POST code display that can help you identify problems.

02 INSTALL CPU AND MEMORY

Removing the CPU socket protection cover, unhook the lever pull it up and lift the socket lid. Orientate the CPU so its shape matches that of the socket, then move the CPU over the socket at a low height, to

minimise the chance of damaging the socket's delicate pins if you drop the CPU. After that, close the socket lid and return the lever to its latch.

Now you can install the memory, starting with a single module – if the system boots fine, install the second module and boot it again – this process will help you to identify faulty modules. Putting the modules into the first and third slots (among other combinations) will usually enable dual-channel memory mode, but consult your motherboard manual to be sure.

03 MOUNT STOCK COOLER AND CONNECT SSD

You don't need to go install the SilverStone cooler just yet. In the CPU box, you'll find an easy-to-install Intel stock cooler that you can use to test the system works. It has thermal paste pre-applied, so you just need to mount it and connect the fan cable to the

motherboard's CPU fan power header. Now connect the SSD to the motherboard using one of the latter's SATA data cables.

04 INSTALL GRAPHICS CARD AND CONNECT POWER

Now install the graphics card into the motherboard's top 16x PCI-E slot and hook up your monitor to the appropriate port on the back of the card. Place the PSU next to the motherboard and connect the SSD to one of the SATA power connectors and the motherboard's 24-pin ATX socket (on the right-hand side of the board) and 6-pin CPU socket (at the top left) to the corresponding plugs on the power supply. The R9 380 graphics card uses a single 8-pin PCI-E connector, which also needs to be hooked up to its corresponding plug on the power supply.

Finally, connect your keyboard and mouse to the motherboard, plug your PSU into the

01



02

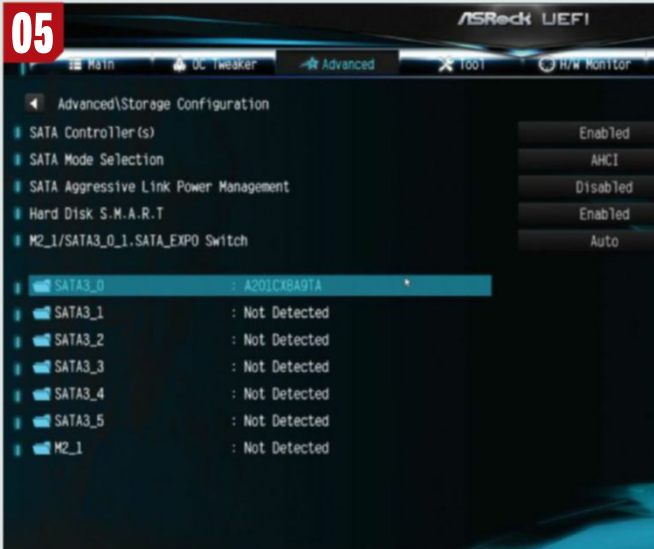


03



04





mains and use the motherboard's power button to turn on the system. If you're using a motherboard with no on-board power button, you can use a metal screwdriver to short the pins for the case's power button on the motherboard – you can find their location by consulting your motherboard manual.

05 CHECK THE EFI

Hopefully, the system will power on. If not, there may be a loose connection somewhere – try removing the components and reseating them one by one – if there's still no joy, you may have a faulty component in your setup. When your system boots, head straight into the EFI by tapping the Del key and then check that both the memory module and SSD have been picked up by the motherboard – the latter may be located under an advanced section in the storage configuration menu. If it's all working fine,

power down the system, install the second memory module, check the memory section in the EFI again, then dismantle your system ready to install it into the case.

06 MOUNT THE COOLER

Remove the stock cooler from the motherboard, then clean the thermal paste from the CPU using a cotton or microfibre cloth and some isopropyl alcohol if necessary. You can then apply the thermal paste that comes with the SilverStone AR01, according to the instructions. Your next step is to mount the cooler – the AR01 uses a backplate and four pins that secure on the top side of the PCB – install these parts, mount the cooler then connect the fan to the large heatsink, with the fan exhausting air through the cooler to the rear of the case, as shown. Finally, connect the fan's power cable to a CPU fan header on the motherboard

07 INSTALL MOTHERBOARD AND CONNECT FRONT PANEL

With the cooler attached, put your motherboard's rear I/O panel into the space at the back of your case, and go ahead and install the motherboard into the case, lining up the screwholes with the corresponding standoffs in the case, then screw it into place with the screws provided with the case. You can now connect the motherboard's front panel pins to the corresponding cables in your case – these pins will provide USB 2 and 3 headers, an audio header and the front panel connectors for any LEDs, plus the case's power and reset buttons.

08 INSTALL THE GRAPHICS CARD AND SSD

The graphics card slots into the top large 16x PCI-E slot and must be secured with screws at the rear of the case. The SSD installs into



one of the combined 3.5in/2.5in drive bays – at this point, it's also worth removing the case's central drive bay to improve airflow to the graphics card.

09 INSTALL THE PSU

The Agos' PSU mount makes use of the base-located dust filter, and you need to install the PSU with the main fan pointing downwards. Install the PSU, then route the cables you need for your components behind the motherboard tray using the cable-routing holes. Then pass them back through the case to the front using different routing holes, one by one, to connect them to the graphics card, motherboard, and SSD.

10 CONNECT THE CASE FANS

The Agos has two fans installed as standard – one at the front and another at the rear. Connect them to the case fan headers on the motherboard.

11 CABLE TIDYING

Behind the motherboard, the case includes several cable anchor points to tie up the cables, so use the included cable ties to group sets of cables together to keep them out of the way – you shouldn't have any of these cables sitting in bunches in the main chassis chamber, as you'll end up restricting airflow and blocking access for upgrades, plus it looks untidy.

12 POWER ON AND INSTALL WINDOWS

When all the bits are connected and installed, connect the power cable to the PSU and power on the system. If it doesn't power on, first check that the PSU power button is in the on position and that the front panel power button cable is connected to the correct pair of pins on the motherboard.

We haven't included an optical drive in this build because, if you're installing Windows

10, it's easy to create a USB drive to install the OS in a matter of minutes – much faster than a DVD. Head over to <http://tinyurl.com/win-tool-usb> and download Microsoft's Media Creation Tool. This tool allows you to download a copy of Windows 10, create a USB install disk and then install Windows before using the genuine key code that comes with a new copy of Windows to activate it.

On our ASRock motherboard, to boot from the USB stick and install Windows, tap F11 during bootup, and you'll then be able to temporarily select the USB stick as a boot device to install Windows.

Once you're sitting at the Windows desktop, allow the system to install any updates, then head over to www.ninite.com, where you can pick your favourite programs and download an exe file to grab the latest versions and install them automatically, saving a lot of time.

BASE CLOCK OVERCLOCKING

There are a few issues to consider before applying any of the BIOS files we discuss below. Firstly, overclocking your CPU in this way will temporarily disable the integrated Intel graphics and, as a result, you'll need to use a discrete graphics card. This situation isn't an issue if you're building a gaming system, but it currently isn't possible to build a CPU-only system that's overclocked in this way.

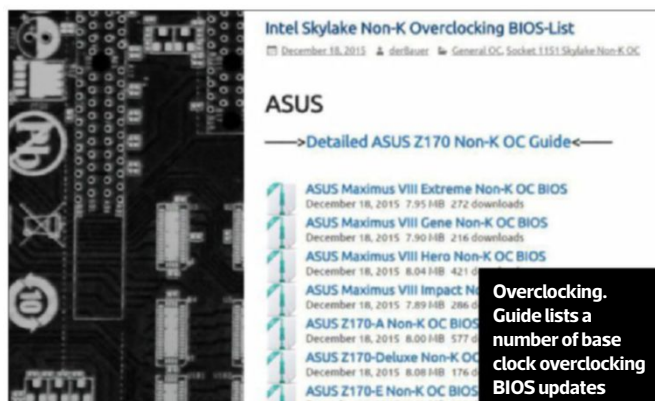
Secondly, the CPU will be unable to take advantage of any power-saving measures such as C-States, and Turbo Mode will be disabled too – the CPU will be fixed at its maximum frequency. As such, power consumption will be higher, although we measured an idle power load increase of less than 10W for the PC as a whole, even at our maximum overclock – hardly the end of the world.

If you make use of the AVX instruction set in modern Intel CPUs then you should also avoid base clock overclocking, as performance appears to be much slower when using one of the new BIOSes. This situation won't likely be an issue for games though. In addition, Windows XP ACPI isn't supported either, although you should be using Windows 7 or above for gaming with such a machine anyway.

Finally – and this might be a little disconcerting – there's no easy way to read the CPU temperature once you're in Windows. That might sound incredibly inconvenient if you're overclocking, but if you're using an air cooler that can handle an overclocked quad-core CPU (the Argon AR01 coped fine with a 4.4GHz Core i7-4790K in our last CPU air cooler Labs test), then a dual-core Core i3, clocked lower, albeit with a higher vcore, isn't going to be a problem with this cooling setup.

GET THE RIGHT BIOS

While it's fairly easy to overclock a Skylake CPU on a compatible motherboard, you have to jump



through a number of hoops to get there. Firstly, you'll need to locate the correct BIOS. Specific versions have been released that allow base clock overclocking – you can't do it using a standard-release BIOS, even if it's the latest version.

Intel hasn't taken kindly to motherboard manufacturers offering these BIOS updates either, so they aren't shouting about it loudly on their websites. There's a list of a number of BIOS updates for Asus, ASRock, Gigabyte and MSI boards, courtesy of the folks at Overclocking.Guide, which you can find at <http://tinyurl.com/baseclock-bioses>. Alternatively, you can find BIOS updates for all of MSI's current Z170 motherboards in this thread on HWbot – <http://tinyurl.com/msi-baseclock> – including the one for the Z170-A Pro.

For ASRock motherboards, you can find correct BIOS updates for base clock overclocking in the BetaZone subsection of the official motherboard support pages. Specifically, you're looking for a BIOS version that supports Sky OC – ASRock's indication that the BIOS supports base clock overclocking. The 2.01 BIOS release for the Extreme4 motherboard we've used in this guide can be found at <http://tinyurl.com/asrock-baseclock>

APPLY THE RIGHT SETTINGS

You'll need to apply a few settings in order for the overclock to work. Not following them will result in

the base clock tweaks not being applied, or your system becoming unstable. Start by flashing the BIOS. This process can be done on all Asus, ASRock, Gigabyte and MSI Z170 boards by placing the BIOS file (extracted from a zip file if necessary), onto a USB stick. Head into the EFI by pressing Del when the system boots, and locate the built-in BIOS flashing tool in the EFI menu. Point the tool at your USB stick and update the BIOS – don't shut down the machine until you're absolutely sure that the update has been applied.

Once you've installed it, head back into the EFI and find the advanced memory and CPU settings, which are located in the OC Tweaker section on the ASRock board we're using. Start by going to the DRAM Timing Configuration menu, and loading the XMP profile for your memory. Now head to the Voltage Configuration menu and set the CPU vcore to 1.375V – applying more voltage yielded no benefit in our testing, but 1.375V is fine if

you're using a good cooler such as the AR01. On the ASRock Z170 Extreme4, we also applied Level 4 Loadline Calibration.

With other motherboards, including the MSI Z170-A Pro, you may also need to manually set the CPU multiplier and ring multiplier to their maximum values – with the Core i3-6100, this setting would be 37.

You're now ready to overclock. To get started, input 105MHz into the base clock setting, after which you should see the resulting CPU frequency jumping from 3700MHz to 3885MHz, as you've increased the clock speed by 185MHz (5MHz x 37). However, you'll also notice that the memory speed has increased. For example, with 2400MHz RAM, increasing the base clock by 5MHz will result in a 120MHz jump in the memory frequency, as the memory clock is linked to the base clock. As such, you'll need to keep the memory frequency to within 50MHz or so of its rated frequency using the divider in the DRAM Configuration menu. With your CPU running at 3885MHz, and your memory running at a safe frequency, save the EFI settings and exit.

When you boot back into Windows, use CPU-Z (www.cpuid.com) to check that the base clock has been applied. Some people using the base clock overclocking technique found that it would occasionally fail to work. Clearing the CMOS or reflashing the BIOS appears to solve most of these problems.



Set the vcore to 1.375V – applying more voltage yielded no benefit in our testing



Input 105MHz into the BCLK setting, and the CPU frequency should jump from 3700MHz to 3885MHz

Using the video encoding test in our benchmarks (downloadable from <http://tinyurl.com/cpc-realbench>), test the system for stability by running it continuously for a while. If it's fine, reboot the system and continue raising the base clock in 5MHz increments until the test fails or the PC doesn't boot properly.

Then revert back to the last good setting and increase the base clock in 1MHz increments until you find your highest overclock that's 100 per cent stable.

As a final test, run our entire benchmark suite and Prime95's smallfft test for six hours to make sure it's stable – be sure to use an old version of Prime95 as new versions have instructions that can cause overclocked CPUs to get very toasty. Version 26.6 is ideal and you can download it from: <http://tinyurl.com/prime96-26-6>

As you can see, our maximum stable overclock was a base clock of 119MHz, which required a vcore of 1.375V, resulting in a clock speed of 4.4GHz, a handy extra 700MHz, increasing the stock frequency by 19 per cent.

OVERCLOCK THE GRAPHICS CARD

Download and install the latest version of Asus GPU Tweak II from www.asus.com under the graphics card's support section. Open the program and select Professional mode in the bottom right. Start by unlinking the GPU clock and GPU voltage using the small symbol on the right. Now increase the core voltage by +50, raise the power limit to maximum

and then increase the core clock by 120MHz. This frequency is 10MHz lower than our maximum stable result from last month's Labs test, so try it out in a few games to make sure it's stable and that there are no strange visual effects, artefacts or stability issues.

Now increase the memory to an effective frequency of 6.28GHz. Again, this figure is a little less than we managed last month, just to be safe. Head back to do some stress-testing and, if your system is stable, you can try to squeeze out a little more performance.

PERFORMANCE ANALYSIS

As you can see from the benchmark results on the right, the extra clock speed results in significant gains in RealBench 2015. In fact, in our Gimp image editing test, which responds more to clock speed than more cores, our overclocked budget system was significantly faster than a quad-core Core i5-6600K system at stock speed.

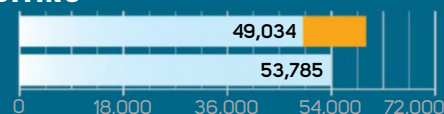
Not surprisingly, the Core i5 was quicker in our other RealBench tests, which are multi-threaded to take advantage of additional cores, but the extra 700MHz still resulted in a significant improvement to performance.

Where our budget rig really shines, though, is in games, which even now don't see big benefits from having more than two CPU cores. Our sub-£600 system never dropped below 30fps in Fallout 4 at 1080p, and that's with Ultra settings, and its 37fps minimum in Crysis 3 at 1080p with Very High settings is great too. **GPU**

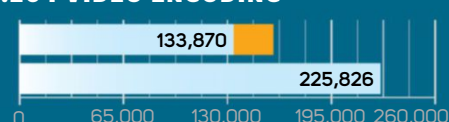
RESULTS

CUSTOM PC REALBENCH 2015

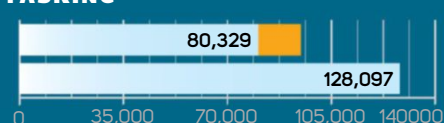
GIMP IMAGE EDITING



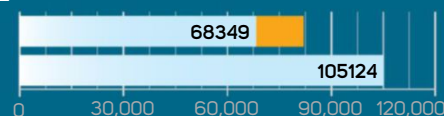
HANDBRAKE H.264 VIDEO ENCODING



HEAVY MULTI-TASKING

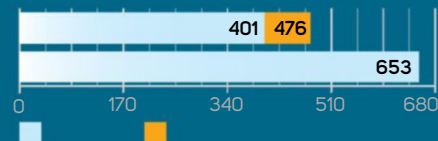


SYSTEM SCORE



CINEBENCH R15

64-bit CPU Test

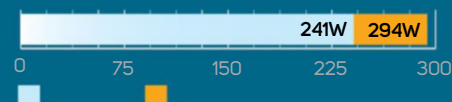


POWER CONSUMPTION

Idle

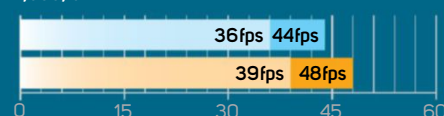


Load



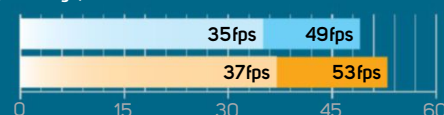
TOTAL WAR: ATTILA

Quality Settings, 1,920 x 1,080, 0x AA



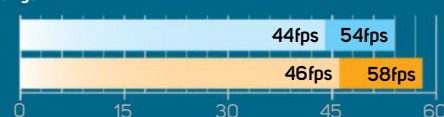
CRYSIS 3

1,920 x 1,080, Very high settings, 0x AA

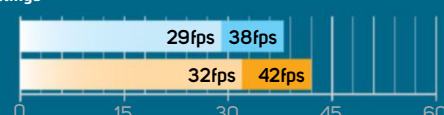


FALLOUT 4

1,920 x 1,080, High settings



1,920 x 1,080, Ultra settings





TAMING THE WILDERNESS

Online abuse in gaming and over social media is widespread and severe. Rick Lane investigates why it happens, the damage it inflicts and how it can be stopped

It's common knowledge that the Internet has a nasty side. From petty and vindictive arguments in comments sections to flaming in online games, the Internet can be a hostile and volatile place. Indeed, a whole lexicon has arisen around the subject of how to avoid the worst excesses of interacting online, such as 'don't read the comments' and 'don't feed the trolls'.

The ugly side of the Internet is viewed as part of its essential nature, an unfortunate but necessary evil in its capacity as a free and open

platform. Sure, someone swearing at and insulting you in a comment isn't very nice, but it boils down to words on a screen from someone thousands of miles away; how hurtful can that be?

The truth is – very. What's considered a general attribute of the Internet comprises numerous and specific problems such as abuse, harassment and cyberbullying.

'I don't really understand why they do it, to be honest,' says Holly Brockwell, editor of Gadgette, a technology website designed

specifically for women, a fact that makes her a frequent target of misogynists on social media alone. 'You can see the things that anger people are women having an opinion, women having a platform. Starting my own business seems to have annoyed them.'

'Having opinions on my body and autonomy over my body seems to have annoyed them ... they seem to find it really threatening.'

Women are particularly targeted by online abusers and harassers, both in the amount they receive and

A HARASSER NOT ONLY INSTRUCTED BROCKWELL TO KILL HERSELF, BUT REFERRED DIRECTLY TO THE SUICIDE OF HER FATHER

its severity, and it seems to be worse if they have a significant online presence and are outspoken about the issues with which they have to deal. Brockwell counts at least three instances in the last 12 months when online misogynists have lashed out against her.

Most recently was over the shutdown of the controversial app Stolen, which let users buy and sell people's Twitter accounts like trading cards. Some individuals attributed the app's closure to Brockwell, who had recently interviewed the creators and, ironically, highlighted its potential to be used as a tool for harassment.

Brockwell points out that, when the abuse happens, it is akin to a torrent. 'When it comes in waves like that, it goes everywhere. I get it in my personal email, I get it on my website, I get it in my work email, work Twitter, my personal Twitter, my Facebook, my Instagram, my LinkedIn – it feels like it's pouring through the windows. You can't get away from it. The only thing you can do is not go online, and that's not really very fair.'

Brockwell describes most of this abuse as 'stupid'; general insults that she personally finds not too hard to brush off, although that doesn't make it any less unpleasant. The insults include 'I hope you die', and sexual or misogynist slurs, such as 'whore, slut, bitch'. Occasionally, though, something especially insidious slips through the net. In one example that wasn't triggered by anything specific, a harasser not only instructed Brockwell to kill herself, but referred directly to the suicide of her father.

'It had a picture of the way my dad died,' Brockwell says. 'That guy has gone to the effort of making a new Twitter account specifically. He'd obviously looked into what happened to my dad, and he put the picture behind a bit.ly link so that he could see when I'd seen it.'

Brockwell's experience may sound extreme, but it seems fairly typical of the experience of many women with even a moderate online presence. Abusers don't simply hurl insults; they research your background, where you live, your friends, relations or partners, everything they can find about your personal life. It isn't solely women who are targeted, of course, although misogynistic abuse online appears to be particularly endemic.

Why does online abuse happen?

So why does this happen? What drives the individuals behind online abuse to do it, and what effects does it have on those on the receiving end? The answer is both surprising and important. 'It's no different from any other form of abuse or bullying,' says Phil Reed, professor of psychology at Swansea University. Reed specialises in several areas, including online addiction and autism. 'The characteristics of the people who abuse – in all sorts of ways – other people on the Internet are very similar to those whom you'd see in everyday life.'

Reed refers to a psychological model known as the Dark Tetrad, which comprises narcissism, Machiavellianism, and psychopathy. In other words, a powerful sense of self-regard, an inability to empathise

with others and a need to manipulate other people to service your own ends. 'If you have those together, you've got the kind of seeds of someone who can be quite abusive and manipulative.'

Online abuse is a particular problem because of how the Internet facilitates it. 'If you go there [the

Internet] with an impulsivity problem,' says Reed, 'that's great for impulsive people because you get your answers straightaway ... you get back what you put in, and if you tend to be impulsive to start with, you're going to get *more* impulsive. If you're aggressive to start with, you're going to get *more* aggressive.'

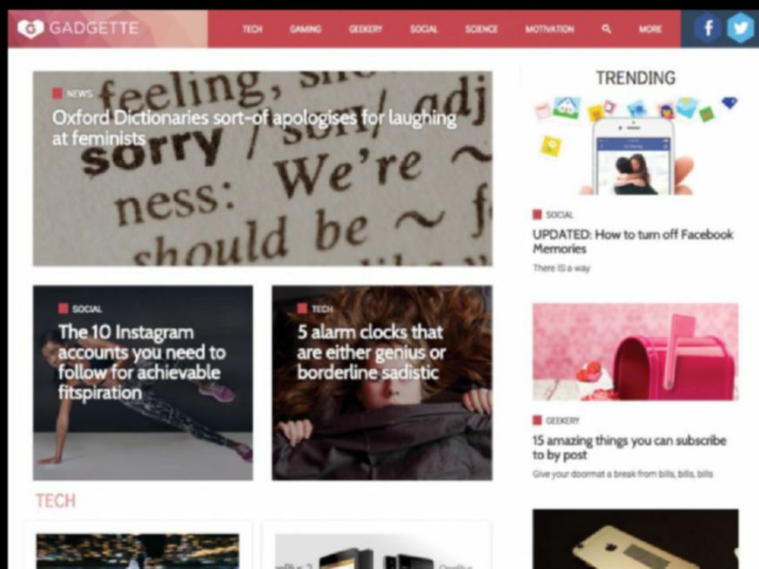
A commonly cited problem with online abuse is how the Internet enables people to act anonymously; an abuser who knows they're less likely to be caught in the act is only going to find this aspect encouraging. However, the issue is a little more complex – the removal of any kind of face-to-face interaction on both sides compounds the likelihood of abuse. It makes it easier for aggressors to abuse and harass, and it makes people at a higher risk of being targeted more likely to suffer abuse.

As an example, Reed refers to individuals with autism. 'They use the Internet an awful lot for communication purposes because it cuts out all of that nasty, messy face-to-face stuff they don't understand. However, because of their social problems and understanding of social responses, it's quite a worrying area for them because they take things literally. For example, if a troll or abuser gets into a chatroom for



Phil Reed, professor of psychology at Swansea University

Holly Brockwell is editor of Gadette, a technology website specifically for women



people with autism and says something nasty to one of them, they can struggle to understand this event in a broader social context.'

Similarly, individuals who suffer from mental illnesses, such as depression or social anxiety, also tend to have a higher than average Internet use, as again it enables them to communicate with other people and discuss their own struggles in an environment that's physically more secure for them. But this also raises the likelihood of their being attacked. 'Because of their underlying depression, they're very vulnerable to negative comments,' says Reed. 'And sadly, we've seen instances where people have decided to take their own lives because of things that people have said to them.'

In short, online abuse is often perpetrated by the same types of people as real-life abuse, and its effects should be taken just as seriously. The Internet makes the difference in that it increases the likelihood that abuse will occur, and also makes it harder to stop. The open and dispersed nature of the Internet means responsibility falls in the gaps between government, corporation and individual, while the ease with which abusers can hide makes effective policing extremely difficult.

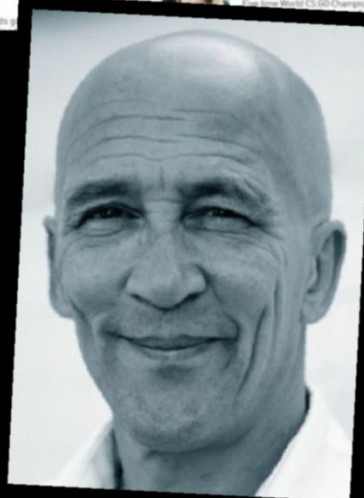
Tackling the problem

So how can the problem be tackled? Firstly, it's important to recognise the complexity of the issue. That doesn't

**SADLY WE HAVE SEEN
INSTANCES WHERE
PEOPLE HAVE DECIDED
TO TAKE THEIR
OWN LIVES
BECAUSE OF THINGS THAT
PEOPLE HAVE SAID TO THEM**



Cybersmile's gaming section is dedicated to tackling abuse in multiplayer games



Dan Raisbeck,
co-founder of
Cybersmile

mean the difficulty of finding a solution, or arguments for and against more effective policing, but the fact that there are many types of abusive behaviour that occur online, and that different areas and communities have different problems. In breaking down the issue and addressing diverging areas specifically, it becomes easier to identify and implement effective solutions.

That's the approach of the Cybersmile Foundation, a non-profit organisation dedicated to tackling cyberbullying. Originally founded by parents whose children had been victims of cyberbullying, Cybersmile tackles all forms of digital abuse. However, last year, Cybersmile opened a new section of its website dedicated specifically to tackling abuse that occurs in gaming, meaning behaviour such as flaming and raging in online games.

'The gaming communities comprise a unique area when you look at harassment and abuse, and how it's defined,' says Dan Raisbeck,

co-founder of Cybersmile. To begin with, abuse in competitive multiplayer games is usually entirely reactive, and rarely transitions into the more malicious, persistent cyberstalking seen on social media.

Game rage

In addition, many of the toxic elements of competitive online gaming have been considered a natural part of that intense environment for many

years. 'This is how they want the game to be played,' Raisbeck explains. 'This is how they want to interact with each other and it does become, for many gamers, this sort of constant narrative. What others would call maybe "flaming" or "raging" or whatever, to each other, is part of the adrenaline rush of playing these games to these people.'

Cybersmile's approach to combating this problem is primarily educational, attempting to make everyone involved aware of the problems and encouraging them to seek solutions. They approach the community and try to raise awareness about these issues, working with spokespersons such as professional Counter-Strike player Stephanie Harvey to engage with the community. 'We find that coping strategies emerge through the users themselves who've had experience, and you'll find a lot of interesting videos from streamers and gamers about controlling rage online,' says Raisbeck.

Cybersmile also helps individuals who have been the targets of in-game abuse by providing support and information about how to better protect themselves while playing online. 'Engaging with the community does come with risks sometimes. It's worth doing your homework, researching the game, getting involved in seeing what support they have, seeing what the reporting procedures are like, asking whether your personal details are being stored correctly, and so forth.'

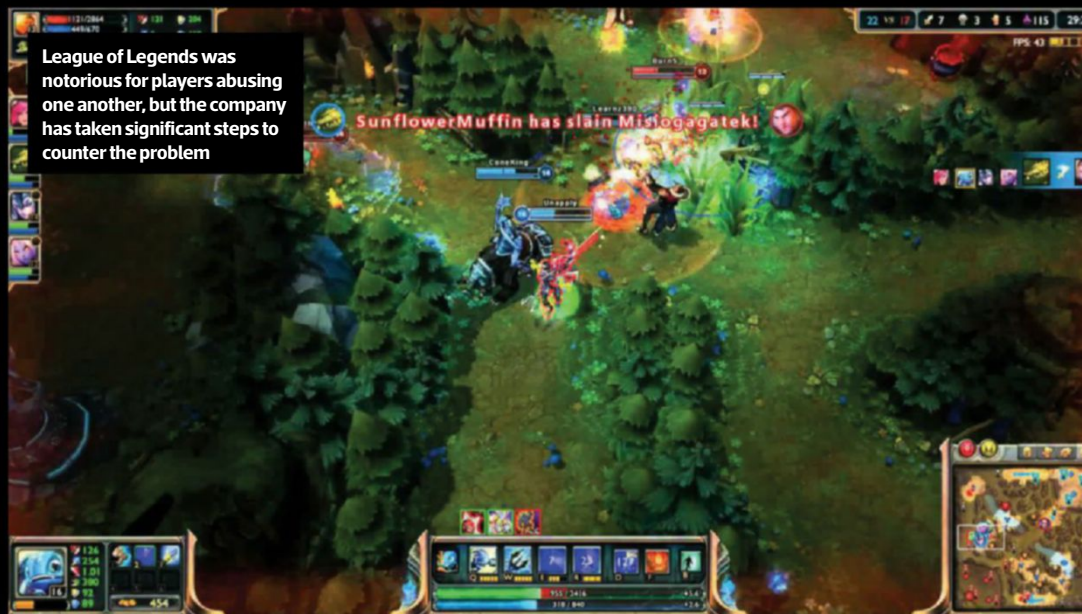
Lastly, Cybersmile liaises with the developers themselves to discuss the

problems within their communities. 'We find that a lot of them are trying to take steps to manage this problem,' says Raisbeck. A good example is Riot games, creator of the enormously popular League of Legends. Games such as League of Legends are notorious for their toxic communities and, as a result, Riot now employs a team of designers whose job is to analyse data regarding what goes on in the game's chat system, and create machine-learning algorithms that reward positive behaviour, and punish rage and abuse. As of September 2015, it was reported that 92 per cent of players who had been caught by the system using abusive language hadn't reoffended.

With the right motivation and a little ingenuity, it's possible for companies whose products are community-reliant to cultivate friendlier environments. It requires motivation, though, and when it comes to social media, the desire for change doesn't seem to be as urgent.

'So far, nothing I've ever reported to Twitter or Facebook has been judged as breaking their rules,' says Brockwell. 'Eventually, accounts have been suspended when I've kept up about it and I wouldn't leave it alone,' she says, but she gets little support when she first 'sends a report and says "This guy has created an account..."' Brockwell points out that 'it's IN their rules – you can't specifically harass people and make an account just to have a go at somebody, but when you do exactly that nothing happens.'

Brockwell believes that a significant part of the problem is that it's simply not possible to understand just how being



INTERNET COMPANIES HAVE CHANGED OUR WORLD. BUT I SEE NO SIGN OF THEM TAKING ON THE RESPONSIBILITY THAT COMES WITH THAT POWER

repeatedly abused online by a large number of people affects your life until you've experienced it directly, and that goes for many of the founders and managers at these social media outlets. 'They keep guessing, and that's why they keep messing up. They don't know ... if they actually spoke to some people,

Cybersmile has multiple gaming spokespersons, including Counter-Strike world champion Stephanie Harvey

and got some people in who had experienced this stuff, and knew what it was like – and I'm sure any woman online would be able to help them out with that – they might actually make some difference.'

Another potential solution is simply to remove the ability for individuals to be anonymous – you could still maintain anonymity to the public, to prevent stalking, but the social media platform itself could bind accounts to specific people and restrict them to a limited number of accounts. However, Brockwell sees such a situation as unlikely. 'They want people to make tonnes of accounts because it looks good for their user numbers – they're not going to do that, basically.'

Of course, it's important to protect freedom of speech on the Internet, but there's a difference between stating an opinion and dishing out threats and harassment – activities that would result in restraining orders outside the online world, but appear to be acceptable online.

Social media platforms are also financially reliant on the communities they foster, and they should have a responsibility to protect the individuals within that community. Professor Phil Reed likens it to a feudal society. 'The lords and barons controlled the world, but there was a phrase that went along with that called "Noblesse Oblige", which came with some responsibilities.'

'Internet companies, broadly defined, have changed our world. But I see no sign of them taking on the responsibility that comes with that power,' he concludes. **GPD**





GARETH HALFACREE'S

Hobby tech

The latest tips, tricks and news in the world of computer hobbyism, from Raspberry Pi, Arduino and Android to retro computing

REVIEW

LeMaker Guitar

The last LeMaker product I reviewed was the Banana Pro back in July 2015, and if you thought the Chinese-based electronics company had finished drawing inspiration from the Raspberry Pi Foundation when it dropped the 'Banana Pi' branding, the Guitar will soon disabuse you of that notion. Based in no small part on the Raspberry Pi Compute Module, the Guitar serves to fill a gap in the market, being an affordable computer-on-module (COM) in a 204-pin SODIMM form factor.

So far, so Compute Module. However, while the Raspberry Pi Foundation has been slow to replace the Compute Module's aging single-core ARMv6 BCM2835 system-on-chip processor, the Guitar boasts a quad-core ARMv7 chip running at up to 1.3GHz, sitting alongside a PowerVR SGX544 graphics processor. There's also 1GB of DDR3 memory included on the SODIMM module itself, along with a combined audio and power management unit

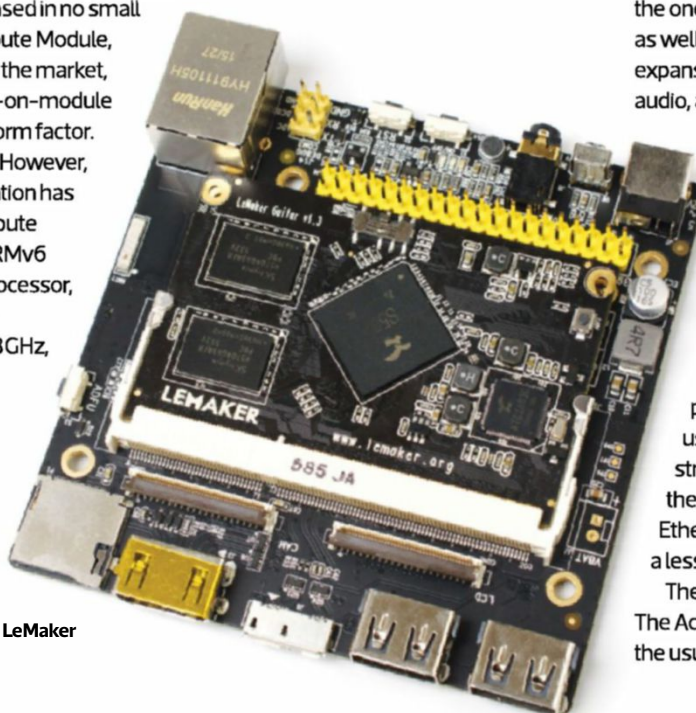
and 8GB of on-board flash storage. That's a lot of hardware, and the footprint suffers for it.

While the Compute Module is roughly the same size as a standard DDR3 memory SODIMM, the Guitar is a fair bit longer, measuring 68 x 44 x 5mm. The Compute Module's benchmark results are around ten

times slower than those of the Guitar, though, completing a SysBench run in around 500 seconds, compared to just 51.6 seconds for the Guitar, and the Compute Module has no on-board storage at all.

So, the Guitar is faster but bigger. It also boasts a more impressive baseboard than the one provided with the Compute Module: as well as micro-SD support for storage expansion, it includes HDMI 1.4a video and audio, analogue video and audio, two USB 2 ports, one USB 3 OTG port, an infrared receiver, a camera and even an on-board microphone. There's also a 10/100Mb/sec Ethernet port and a 2.4GHz 802.11a/b/g Wi-Fi and Bluetooth radio module, both of which are provided by the baseboard and are absent from the module itself. Their performance is poor though – the small chip antenna used for wireless communication struggles with weaker signals, while the theoretically 100Mb/sec-capable Ethernet port maxed out during testing at a less than impressive 32.11Mb/sec.

The processor, though, is a different story. The Actions S500 SoC makes a change from the usual AllWinner parts found on Chinese

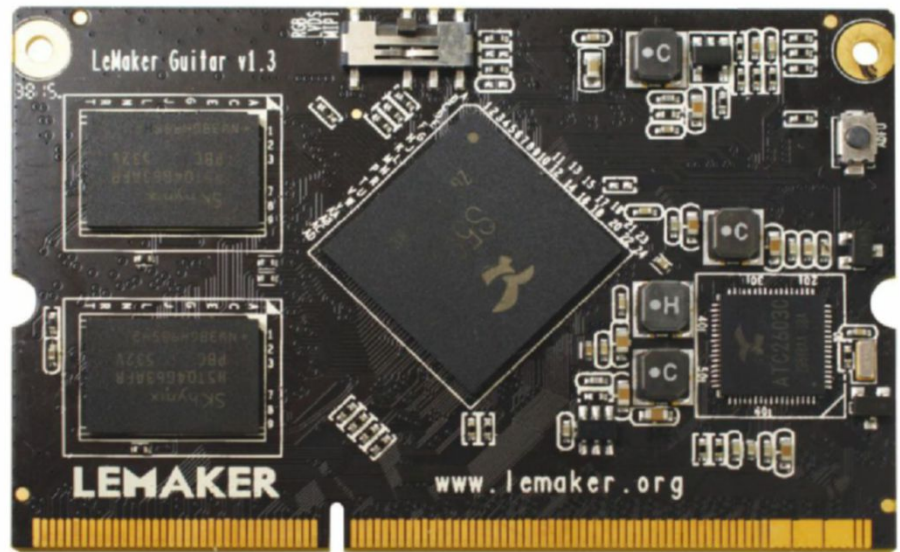


No prizes for guessing from where LeMaker continues to draw its inspiration

The Guitar boasts a quad-core 1.3GHz ARMv7 chip, sitting alongside a PowerVR SGX544 graphics processor

Pi-alikes, and its four 32-bit Cortex-A9 processing cores easily beat the cores found on the Raspberry Pi 2; while the Guitar completed a SysBench run in 51.6 seconds, the Pi 2 took a more leisurely 74.5 seconds. Sadly, the GPU is a different story. As with other PowerVR products, driver support outside the Android ecosystem is poor. If you're running LeMaker's Android 5 build for the Guitar, you're laughing; any other Linux distribution, though, requires you to manually install accelerated drivers that were built using Imagination's driver development system – a process which I spectacularly failed to complete, despite following LeMaker's detailed instructions on the official company wiki site, leaving the Guitar failing to display an image from its HDMI port.

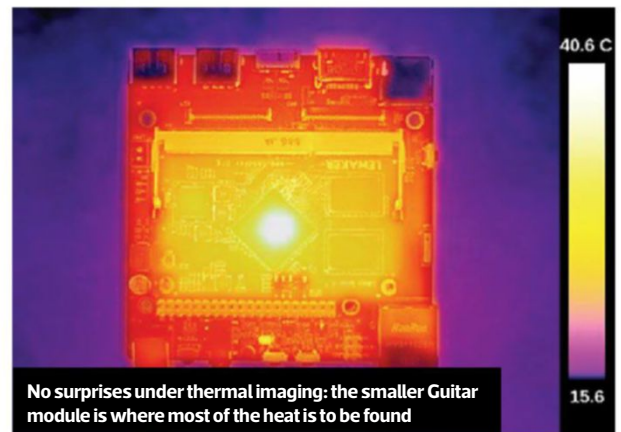
This problem isn't unique to the Guitar, though, and there are still legitimate reasons to pick up LeMaker's latest design over the many alternatives on the market now. Anyone whose projects are CPU-limited will enjoy a noticeable speed boost over a Raspberry Pi 2 at roughly the same overall cost, and with the familiar 40-pin GPIO header with 28 pins user-accessible for general-purpose



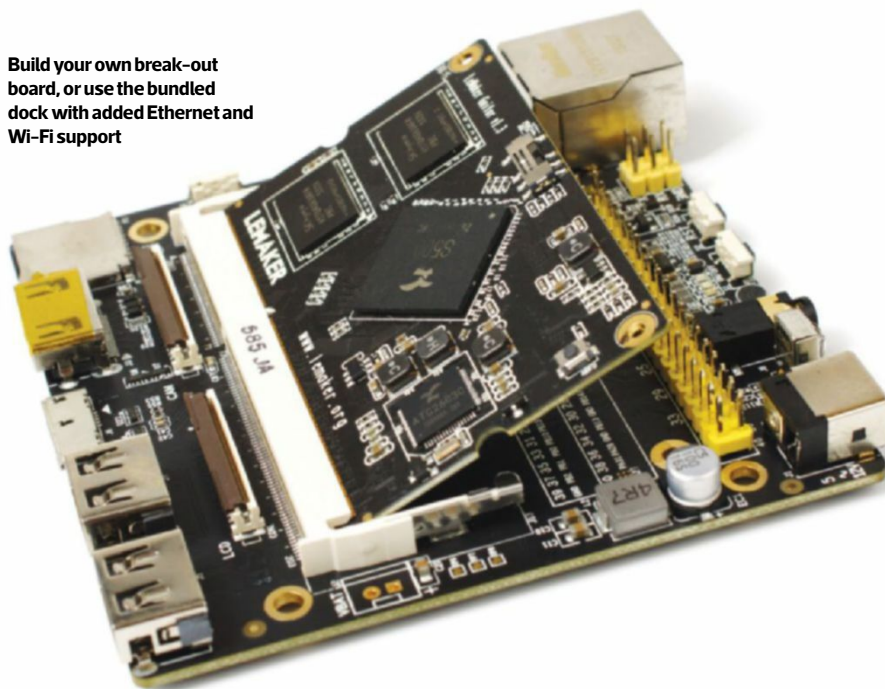
The Guitar's Action SoC is surprisingly powerful, but I failed to get accelerated video working under Linux

programming. Meanwhile, anyone who has been working to develop their own Compute Module-based design should theoretically find it easy to switch over to the larger but more powerful Guitar.

The traditional reason for opting for a third-party board has been broader compatibility. When the Raspberry Pi family was stuck on the outdated ARMv6 architecture, operating system compatibility was limited; the ARMv7 Raspberry Pi 2 changed that situation, introducing the ability to run platforms as diverse as Ubuntu and Windows

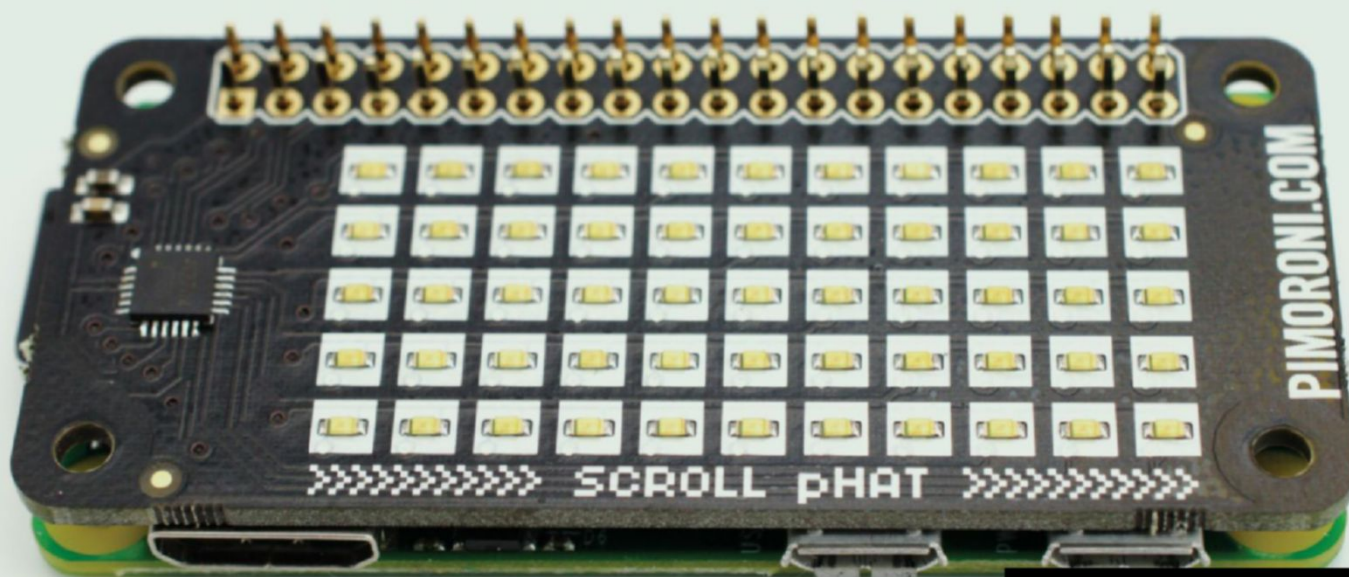


Build your own break-out board, or use the bundled dock with added Ethernet and Wi-Fi support



10. The biggest advantage of the Guitar in this respect is a functional Android 5.0 image, which the Pi still lacks. There are also modified Debian Jessie images in the form of Lemuntu and LeMedia, with the latter booting into the Kodi media player and the former into an LXDE desktop with applications including the IDLE Python environment and AbiWord word processor pre-installed. There are Arch, and Ubuntu MATE images available too, but it's only the Android image that really sets the Guitar apart from the competition.

However, the biggest factor in the Guitar's favour is its price. Despite the Compute Module's poor performance, its target market has always been professional engineers looking to prototype commercial implementations, and the pricing reflects that aim. The Compute Module and baseboard bundle will set you back an eye-watering £80 inc VAT. The more powerful Guitar, by contrast, is available from its official stockist, www.lenovator.com, for \$44.90 (around £30) – a considerable saving for switching away from the comfortable and familiar Raspberry-themed ecosystem.



If you ditch the bundled female header, you can make an 8.7mm-thick machine from a pHAT and a Pi Zero

REVIEW

Pimoroni pHATs

Discounting the Compute Module, the Raspberry Pi Zero is the biggest form-factor shake-up for the single-board computer since it shifted away from a plan to use microcontrollers. Where the new Model A+ was already compact, the Zero is positively minuscule, but what use is a miniature microcomputer if there are no equally tiny accessories to match? That's the thinking behind the pHAT family from Sheffield-based Pimoroni, which launched alongside the Zero with three initial models that perfectly match the Pi Zero's form factor.

There's also a bonus feature: you can optionally solder a pHAT directly to the Zero's GPIO header using strips of 2.54mm male headers. While such an attachment prevents you from easily removing a pHAT, it drops the size of the pairing to measure just 8.7mm thick compared with 16.2mm for the removable version.

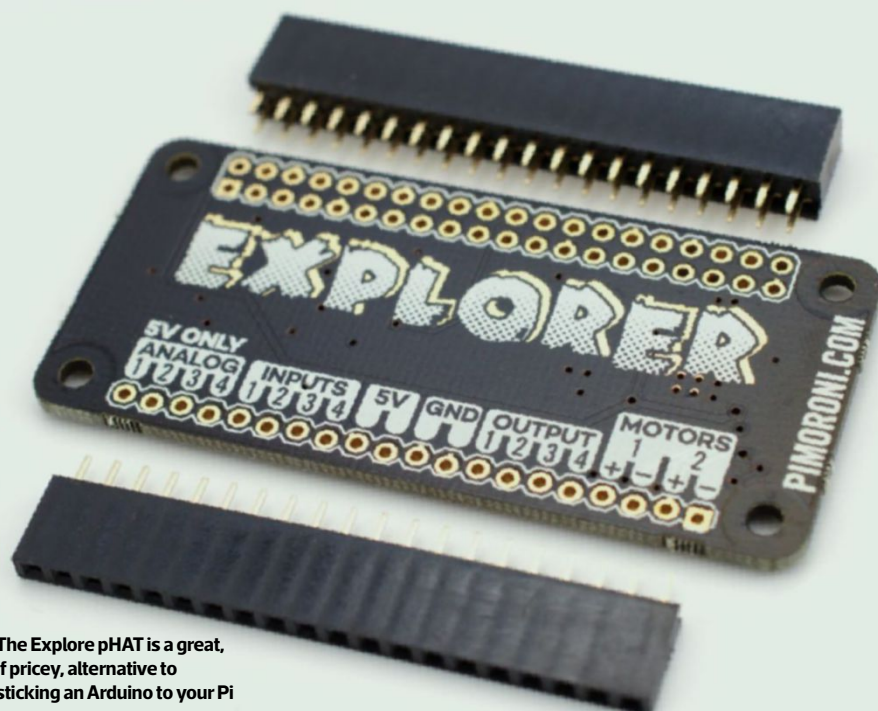
Either way, you'll have to do some soldering: all pHATs are supplied with a female header that you attach yourself. All of these pHATs are available to buy now from <https://shop.pimoroni.com>

Explorer pHAT, £10

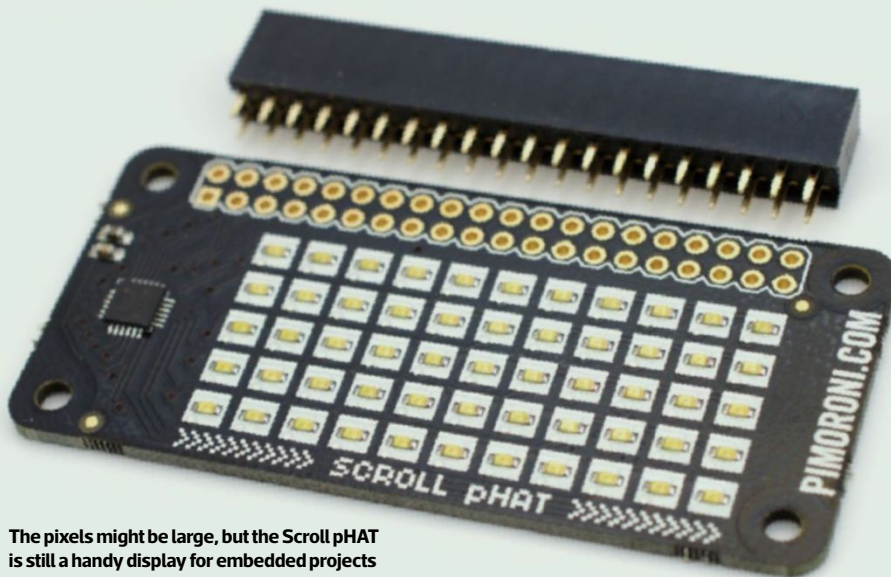
The Explorer pHAT is arguably the most interesting of the three launch models. Based on the full-sized Explorer HAT, the Explorer pHAT boasts three active components to expand the GPIO capabilities of any Pi model – not just the Zero. A dual H-bridge can drive a pair of small motors, and a 12-bit analogue-to-digital converter (ADC) allows the use of analogue sensors across four inputs. Meanwhile, a Darlington array connected to a 5V buffer gives the Pi the ability to use 5V sensors and outputs, rather than the 3.3V from the Pi's own GPIO port.

However, it takes some time to get used to the Darlington array if you're more familiar with true 5V logic devices such as the Arduino Uno. With the Arduino, you use the pin with which you're working as the positive connector and hook up the other end of your device to ground; the Darlington array, though, is there to sink rather than source a 5V signal, which means you have to connect the positive end of your device to 5V and use the pin as a negative connector, which also makes 'on' technically 'off' and 'off' technically 'on', a confusing situation that's neatly sidestepped by the bundled Python library.

While a knock-off Arduino linked to the Pi via serial or USB is cheaper, the Explorer pHAT is undeniably neat. Setting it up is certainly a lot easier than messing around with resistor ladders or bidirectional voltage convertors if you have a selection of 5V hardware you want to link to your Pi.



The Explorer pHAT is a great, if pricey, alternative to sticking an Arduino to your Pi



The pixels might be large, but the Scroll pHAT is still a handy display for embedded projects

Scroll pHAT, £10

While the Explorer pHAT is multi-function, the Scroll pHAT is very much a one-trick pony: it's a 5 x 11 array of surface-mount bright white LEDs, each one individually addressable for on and off, although brightness is a global control. Using the bundled library and examples, it's possible to automatically scroll lengthy messages across the array using a built-in typeface – and, despite the limitations of a 55-pixel resolution – the result is surprisingly readable.

The bundled Python examples, though, suggest that development was a little rushed ahead of the Pi Zero's launch: `sine.py` should, given its name, generate a neat little sine-wave animation across the display, but at some point it's been hacked around to instead show CPU load as a scrolling bar graph and it's never been renamed. If you're curious, though, you can find the original sine-wave code in a code block towards the bottom, which never executes, while fragments for

scrolling the Pi's IP address, a greeting, and a selection of ASCII smiley faces are commented-out further up.

Coding oddities aside, the Scroll pHAT is lovely. And you can get started with it without even programming: an included example supports scrolling any message passed to it from the command line, although it will scroll in a loop until manually terminated.

pHAT DAC, £12

The pHAT DAC is a very specific add-on, but one that adds a lot to the Pi Zero: it restores the missing analogue audio output that was sacrificed in order to maintain the Zero's tiny footprint. Given that one of my plans is to build a compact gaming system into the body of an original 1980s joystick, and use composite video and analogue audio output, the pHAT DAC is a must-have for me. Aside from having to solder the GPIO connector, the pHAT DAC arrives ready-to-run out of the box using a 3.5mm jack for its output. This output

What use is a miniature computer if there are no equally tiny accessories to match?

is line-level though: with no on-board amplifier, the pHAT DAC isn't suitable for use with headphones or unpowered speakers.

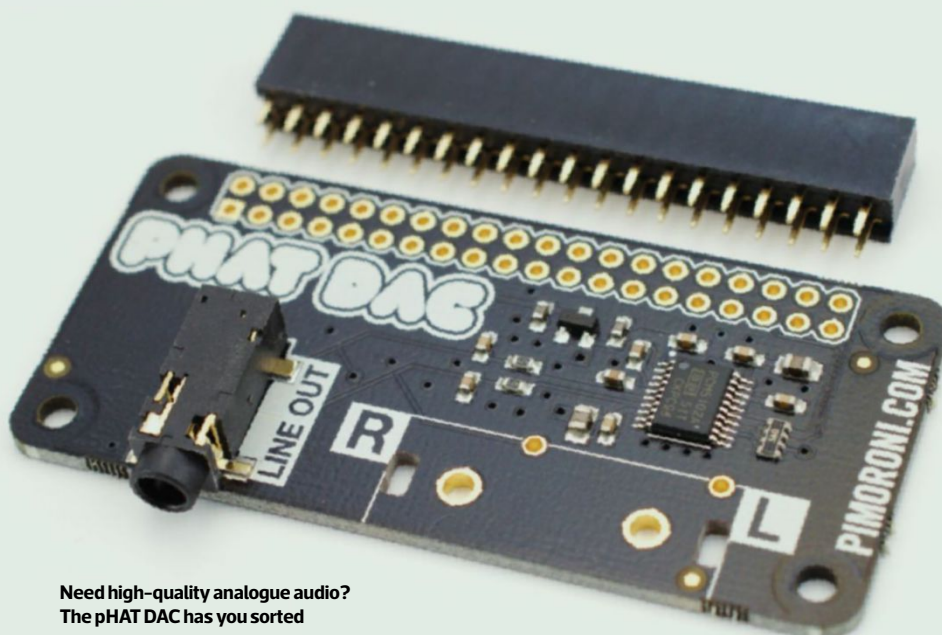
If you're looking to wire the pHAT DAC into a hi-fi or amplifier, there are unpopulated headers for RCA sockets; these connectors aren't included, but they're available separately for £1.50 if you need them. The only problem I encountered with the pHAT DAC was the installation process: at the time of writing, the instructions for setting up the device are outdated and misleading. A bash script to do the work for you has been created by a community member, but it isn't linked from the tutorial page – hopefully, this situation will be resolved by Pimoroni soon.

NEWS IN BRIEF



Philips disables, then re-enables hobbyist Hue access

Philips garnered the ire of its users in late December when it issued a firmware update for its Hue smart lighting products that locked out hobbyist and third-party devices. The move was an apparent attempt to drum up business for its 'Friends of Hue' licensing scheme, despite the Hue ecosystem being built on hobbyist-friendly ZigBee technology. Mere days later, the company apologised and stated that it had 'underestimated the impact this would have on a small number of customers who use lights from other brands'. A new firmware update, rolled out automatically to all users, restored the old behaviour.



Need high-quality analogue audio? The pHAT DAC has you sorted

TUTORIAL

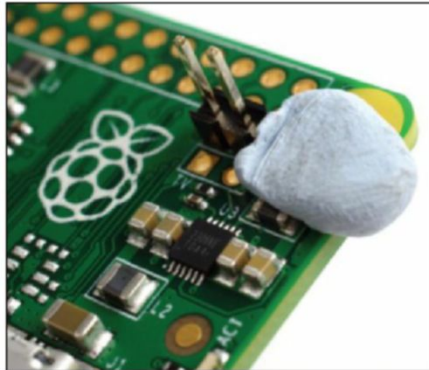
Raspberry Pi reset switch

The launch of the Raspberry Pi Zero (see Issue 150, p94), has reignited interest in using the ARM-based microcomputer family in embedded projects. This lightweight, compact, and low-power device has been selling out solidly since launch – and at £4, that's hardly surprising. There's just one feature the Pi Zero really needs in order to be the perfect low-cost microcomputer for embedded projects: a means of resetting it when your program goes non-linear.

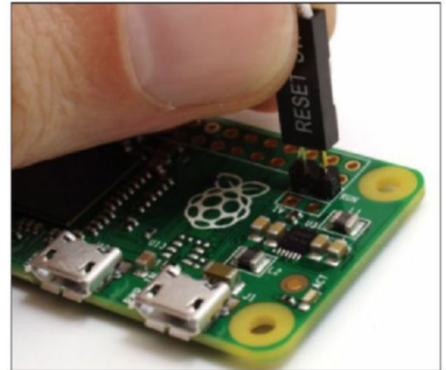
Thankfully, introducing this feature is simple to achieve thanks to a handy, little-known unpopulated header that's common to all modern Raspberry Pi models: the RUN header. A word of warning though – use the reset switch sparingly; just like any PC, if you reset the Pi when it's writing data then corruption is almost guaranteed.

What you'll need

- Raspberry Pi Zero, £4 inc VAT, <http://swag.raspberrypi.org>
- Soldering iron and solder, £10 inc VAT, <http://oomlout.co.uk>
- Male 2.54mm Headers, £1.50 inc VAT, <http://oomlout.co.uk>
- Salvaged PC reset switch, free
- OR**
- Momentary normally-open switch, £2.50 inc VAT, <http://oomlout.co.uk>
- Female-female jumper wires, £5 inc VAT, <http://oomlout.co.uk>



Blu-tac or tape can keep headers in place while you solder



A reset switch from a PC can be connected straight to the header

1 Locate the RUN header

The RUN header can be found on all current Raspberry Pi models bar the Compute Module, and is easy to spot: it's marked with the word RUN. On the Pi Zero, it's found just below the GPIO header at the right-hand side, above the composite video header marked 'TV'. Other models have the RUN header in different locations, while older full-sized Model A and Revision 2 Model B boards have it marked as P6; the original Model B, however, lacks the header altogether.

2 Insert male headers

You can solder the wires of a reset switch directly to the RUN header, but you'll have no way to remove it if you need to change switches or lengthen the wire. Likewise, you can solder a PCB-mount switch to the board,

but it will block access to the composite video and GPIO headers. A better method is to snap two pins from a length of 2.54mm male headers and insert them through the holes, from front to back. Secure them with Blu-tac or tape, then flip over the board.

3 Solder the pins

The through-hole headers on the Pi Zero are reasonably easy to solder, although the copper contact on pin two of the RUN header is relatively small. Make sure you're applying heat to both the pin and the copper contact on the board, then melt your solder into place. Repeat this process with the second pin, then visually check the quality of your joints and make sure you haven't shorted out the pins with excess solder. In my case, I only had extra-long headers available, so I needed to snip the excess; if you're using normal-length male headers, you can skip that step.

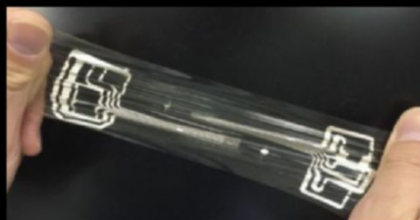
4 Wire the switch

Using a reset switch salvaged from a PC case is an easy way to complete this step: it's already wired with a two-pin female header on the bottom, and it's also the normally open momentary switch type you need. Otherwise, take a pair of female jumper wires and connect them to whichever switch you've purchased; this job may involve slicing one end off the wires and connecting the wires to screw terminals, or soldering spade connectors on to them. Connect the other end to your Pi's RUN header, either way around, and you're done! **GPO**

NEWS IN BRIEF

Panasonic launches stretchy circuit film

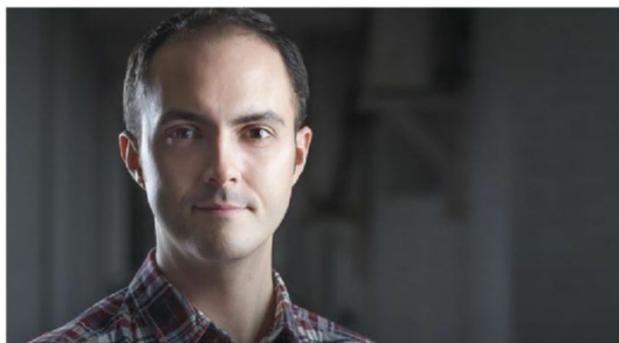
Panasonic has announced the development of a soft, stretchy resin film that it hopes will lead to exciting new devices in the near future. Based on a unique design featuring a three-dimensional cross-linked structure of thermosetting resins, the insulating material can be printed with a silver-based conductive paste to create circuits, which can then be stretched to nearly three times their length without damage. The company showed off the material at the 17th Printed Wiring Boards Expo in January, but commercial availability hasn't yet been announced.



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ANTONY LEATHER'S

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Full cover mini-ITX blocks

A few years ago, if you wanted to cool more than the CPU in a mini-ITX machine, you had to buy a universal VRM waterblock, or do as I did a while back and create your own. Since then, though, we've seen the release of full-cover waterblocks for some of the more popular dinky boards available, such as Asus' Maximus Impact series. With single inlets and outlets, these blocks usually route the coolant over several hotspots or simply have direct flow over the CPU, while dealing with the chipset and VRMs via heat conduction through the waterblock, which makes contact with these other hot spots on the PCB.

It seems that sales of these first blocks have been good enough for boards based on Intel's X99 and Z170 chipsets to receive the same

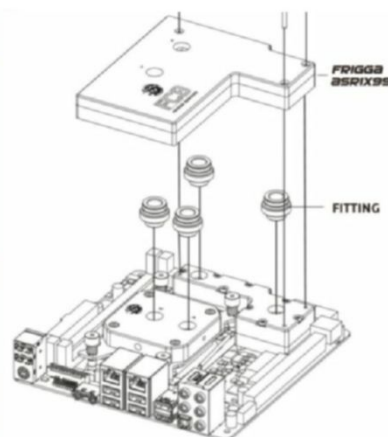
Bitspower's new full-cover waterblock for ASRock's mini X99 board cools the VRMs, CPU and PCH



It's impossible to cool the Maximus VIII Impact's PCH due to the sound card, so EKWB's block just cools the CPU and VRM board

treatment too, as Bitspower and EKWB have released a raft of new full-cover waterblocks for the latest mini-ITX motherboards. To start, EKWB has gone for the logical choice by supporting Asus' Maximus VIII Impact. As I suspected when I reviewed the board last year, though, it's proved impossible to cool the PCH due to the low-riding SupremeFX Impact III sound card, with EKWB just cooling the CPU and VRM daughterboard instead.

Bitspower has two other mini-ITX boards covered – MSI's Z170I Gaming Pro AC and, perhaps more interestingly, ASRock's fantastic X99E-ITX/ac. Both kits are equipped with three separate waterblocks – one each for the VRMs, CPU and PCH, and they're all linked together using a pass-through section that sports two G1/4in ports, with the coolant passing through



each block. The setup caters for all the hotspots, which is particularly important on a mini X99 board. Indeed, ASRock raised the issue of VRM cooling when I asked it for a sample of the X99E-ITX/ac to test the waterblock. It stated that the VRMs need good cooling, especially on X99 motherboards, and that it isn't a good idea to water-cool your CPU and then



Bitspower has also announced a full-cover waterblock for MSI's Z170I Gaming Pro AC



reduce the airflow around the board by moving your fans to radiators.

Thankfully, Bitspower's waterblock should cool the VRMs fine, which is just as well, as the board is likely going to end up in some small, stuffy cases. The X99E-ITX/ac also suffers from a lack of third-party cooling options, due to the fact that it uses a narrow, server-type socket mount – standard LGA2011-v3 coolers and waterblocks don't fit. However, Bitspower has used a custom mount for this waterblock that enables it to fit as normal. I'll be taking a look at Bitspower's waterblock for the X99E-ITX/ac soon.

Hands on with Raijintek's new water-cooling gear

There used to be just a few companies involved in making waterblocks, reservoirs and pumps, but several hardware companies have entered the scene now too. Thermaltake has started offering a complete range of products, for example, and now Raijintek has joined the fray as well.

For starters, Raijintek now offers its own coolant, flexible tubing, pump, two sizes of tube reservoirs and waterblocks for CPUs, GPUs and VRMs. The coolant is a mix of water and propylene glycol, and is available in a range of colours, while the flexible tubing is only available in 9.5mm ID/12.7mm OD size, but it will most likely fit 10/13mm fittings fine.

Raijintek says the pump is relatively powerful, with a flow rate of 480 litres per hour and a maximum 15 feet of head pressure – that's more than a Laing D5. However, it's also considerably louder and, even when using its built-in speed control dial, it was still audible at its lowest speed. It's relatively compact, although the large housing makes it a larger pump than the popular Laing DDC.

The reservoirs have issues, however. For starters, neither of them can be mounted separately from the pump (no mounting materials are provided, unlike most other reservoirs available) – you have to mount them directly to the pump using a male/female fitting, which looks a little unsightly. The first major issue, though,



is that their design means the fill port sits in the middle of two inlets, but even comparatively small 13/10mm compression fittings overlap the port's screw cap, so you can't remove it – you can't fill the reservoir if you use two fittings here. Thankfully, most people only need to use one inlet, so you can use the other to fill it, but the next issue is that the smaller reservoir is poor at bleeding the loop of air.

The problem is that air bubbles get trapped inside the loop, thanks to Raijintek's attempt to offer a waterfall effect, meaning it will take several hours to achieve what most other reservoirs do in a few minutes when removing air from the loop. Thankfully, the larger model didn't suffer from the same issue, but it's a shame, as the reservoirs are otherwise well made and are available in a range of colours, just like Raijintek's cases.

The waterblocks are a little better. They're easy to install and the VRM waterblock should be compatible with a host of motherboards thanks to its adjustable arms. The CPU waterblock especially looks just as good as some of the metal-clad models available from water-cooling specialists. The waterblocks sport microfin cooling structures – as is the norm for waterblocks these days – and while the GPU waterblock's support is limited mostly to older GPUs, the CPU waterblock supports all current sockets from Intel and AMD out of the box. Unfortunately, I didn't have a compatible card to test the GPU waterblock,



Above left: Raijintek claims the pump has a flow rate of 480 litres per hour

Above right: The CPU block supports all current sockets from Intel and AMD

but hooking up the CPU waterblock to EKWB's Predator cooler, and dealing with a 4.8GHz Core i7-6700K, saw it come within 5°C of EKWB's own Supremacy MX waterblock using the same hardware.

Venator Class Star Destroyer V1 by Sander van der Velden

Finally, if you're suffering from post-Star Wars blues, you'll be pleased to know that there's still plenty of Star Wars influence in the PC modding scene, with sci-fi modder Asphix (also known as Sander van der Velden) from The Netherlands recently completing his enormous star destroyer scratch build, and it isn't just a star destroyer with a mini-ITX system inside. The PC holds an enormous quad 140mm-fan radiator straddled with a line of six 120mm fans in the base, along with an MSI GeForce GTX 980 Ti Lightning and, of course, a complete water-cooling system with custom-made reservoirs as the engines. You can see more at <http://tinyurl.com/pc-starwars> **CPC**

The Star Destroyer holds an enormous quad 140mm-fan radiator with six 120mm fans in the base



How to Clean a water-cooling loop

Time to change your coolant and clean your water-cooling parts? Antony Leather shows you how it's done

 **TOTAL PROJECT TIME** / 3 HOURS

Despite what many people think, maintaining a water-cooling system is actually fairly easy. Once installed, your only worry is dust for at least a year or so. After this period, however, detritus and deposits can start collecting in waterblocks and other components. As long as you avoid mixing metals that can lead to galvanic corrosion, though, it's relatively simple to keep your water-cooling system in good shape for years.

It's worth changing your coolant once a year and opening up your waterblocks to check for debris too, as this can impact on their effectiveness. A pump filter can also help, although it will also need to be cleaned. Finally, coolant manufacturer Mayhems offers a cleaning product tailored for PC water cooling called Blitz. We'll be showing you how to use it, and all these other methods, in this month's guide to keep your water-cooled PC in tip top condition.

TOOLS YOU'LL NEED



Mayhems Blitz
cleaning solutions /
<http://mayhems.co.uk>



TIM cleaner /
www.watercoolinguk.co.uk



ATX jumper /
www.watercoolinguk.co.uk



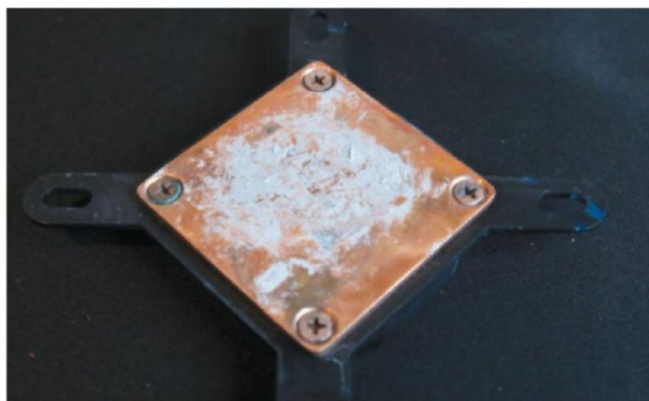
Filter sponge /
www.watercoolinguk.co.uk



Autosol and descaler /
Most hardware stores

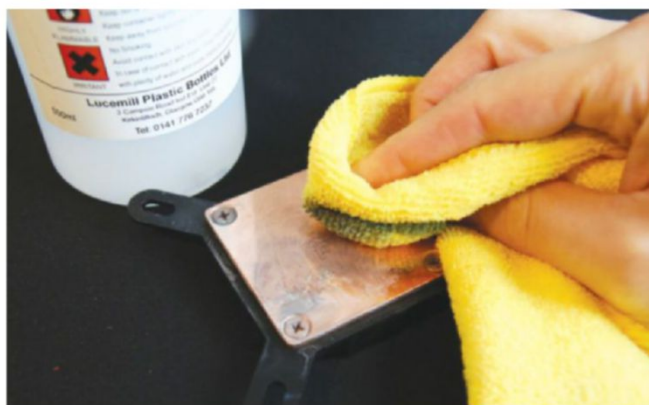


Alphacool Sysclean /
www.watercoolinguk.co.uk



1 / DISCONNECT WATERBLOCKS

Start by checking the individual waterblocks, as any large fragments will need to be removed manually. Due to the delicate nature of a waterblock's interior, even small pieces of debris can affect performance. Drain the system and remove the waterblocks.



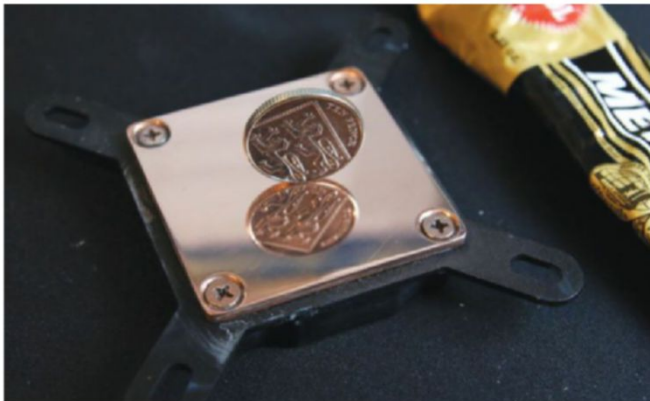
2 / CLEAN OFF THERMAL PASTE

It's just as important to keep the exterior of the waterblocks clean and healthy too. Oxidation and thermal paste can hinder thermal transfer, so clean the base with a TIM cleaner solution or isopropyl alcohol.



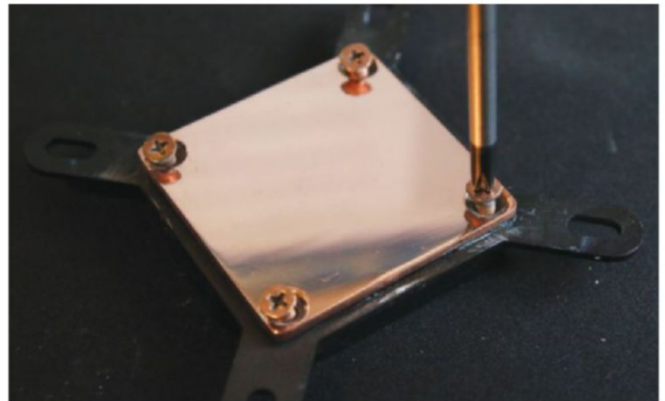
3 / APPLY AUTOSOL

Autosol is brilliant for removing oxidation and any stubborn stains made by coolant, dyes or thermal paste. Apply a raisin-sized portion to the waterblock and rub with a microfibre or cotton cloth. Don't use fibrous kitchen towels or tissues, as they create dust.



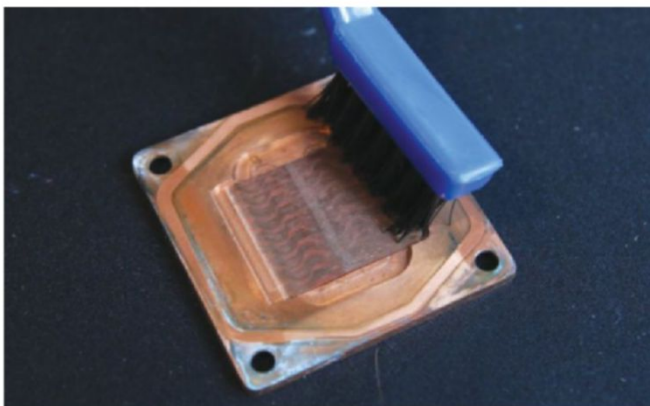
4 / RUB OFF RESIDUE

You'll need to rub fairly vigorously all over the base of the waterblock, in small circular motions. The Autosol will turn black, so you'll know it's doing its job. Wipe off the residue after five minutes or so and inspect the surface – feel free to apply more if necessary.



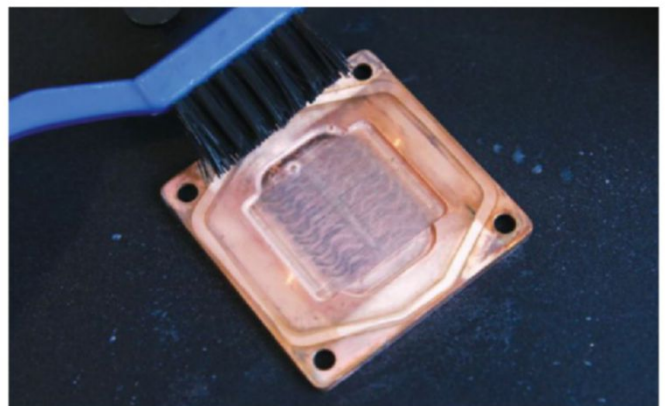
5 / OPEN WATERBLOCK

Getting inside waterblocks is usually fairly painless, as they mostly use crosshead or hex-head screws and aren't sealed units, unlike some all-in-one liquid coolers. Be careful opening it, though, as there can be delicate rubber seals and inserts that need to be replaced precisely.



6 / BRUSH AWAY RESIDUE

The microfins present in most waterblocks do a great job of cooling your CPU, but are just as effective at trapping small particles that come loose inside the loop. Remove any inserts and brush the microfins with a stiff plastic brush to dislodge any particles.



7 / CLEAN WITH DESCALER

Clean the inside with a descaler such as Cillit Bang Limescale and Shine or Alphacool Sysclean. Water it down with a ratio of one squirt to two eggcups of deionised water, use a brush to work it into the microfins and around the inside, and then flush it with deionised water.



8 / MIX MAYHEMS PART 1

The Mayhems Part 1 solution is only to be used on radiators, so you'll need to remove them from the loop first. Using the included protective glasses and gloves, mix the solution with the correct amount of deionised water stated in the instructions.



9 / FLUSH RADIATOR AND FILL WITH PART 1

With the radiator removed, flush it with deionised water then fill it to the brim with the Part 1 and water solution. Tilt the radiator if necessary, ensuring there's no air left inside. The solution will only work if it's in contact with the radiator's interior surfaces.



10 / LEAVE FOR 12 HOURS

Seal the radiator using the G1/4in blanking ports with which it came, or alternatively, blanking ports can be bought for a few quid online. Leave the radiator for 12 hours, shaking it occasionally to ensure all the internal surfaces have made contact with the solution.



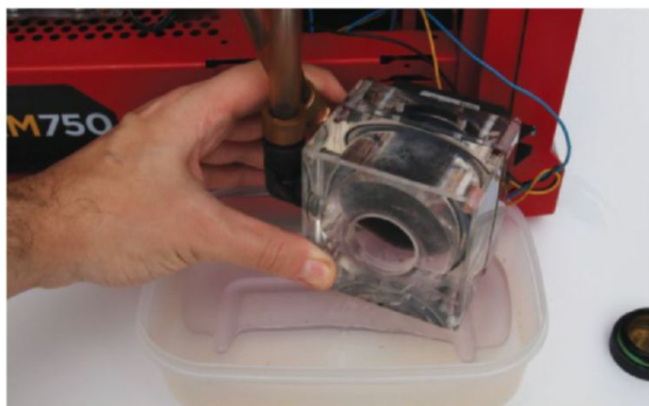
11 / EMPTY CONTENTS

Using an old container or bowl, pour all the solution out of the radiator, being careful not to spill any of it. This job is best performed outside, where you can then pour the liquid down a drain, which is perfectly safe.



12 / FLUSH RADIATOR

It's important to remove all of the Blitz solution before you reconnect your radiator to your water-cooling system. Once you've drained it, flush it thoroughly several times with deionised water.



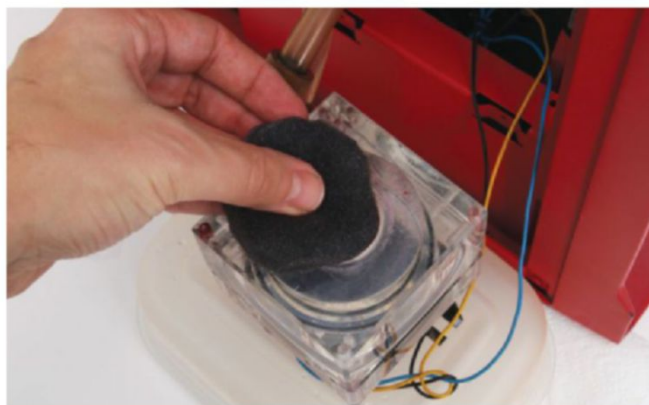
13 / DRAIN OTHER COMPONENTS

Now it's time to prepare your system for using the Part 2 Blitz solution, which gets pumped round all your components. Start by draining the rest of the loop – you'll need to completely empty each component.



14 / REINSERT RADIATOR

Once you're sure the radiator has been fully flushed with deionised water to remove the Part 1 solution, reinsert it into the loop.



15 / ADD FILTER TO RESERVOIR

Add a filter to the reservoir, if you haven't added one already. You can make one easily out of sponge foam, or alternatively, they're available from most water-cooling retailers. This filter will catch any particles loosened by the cleaning process.



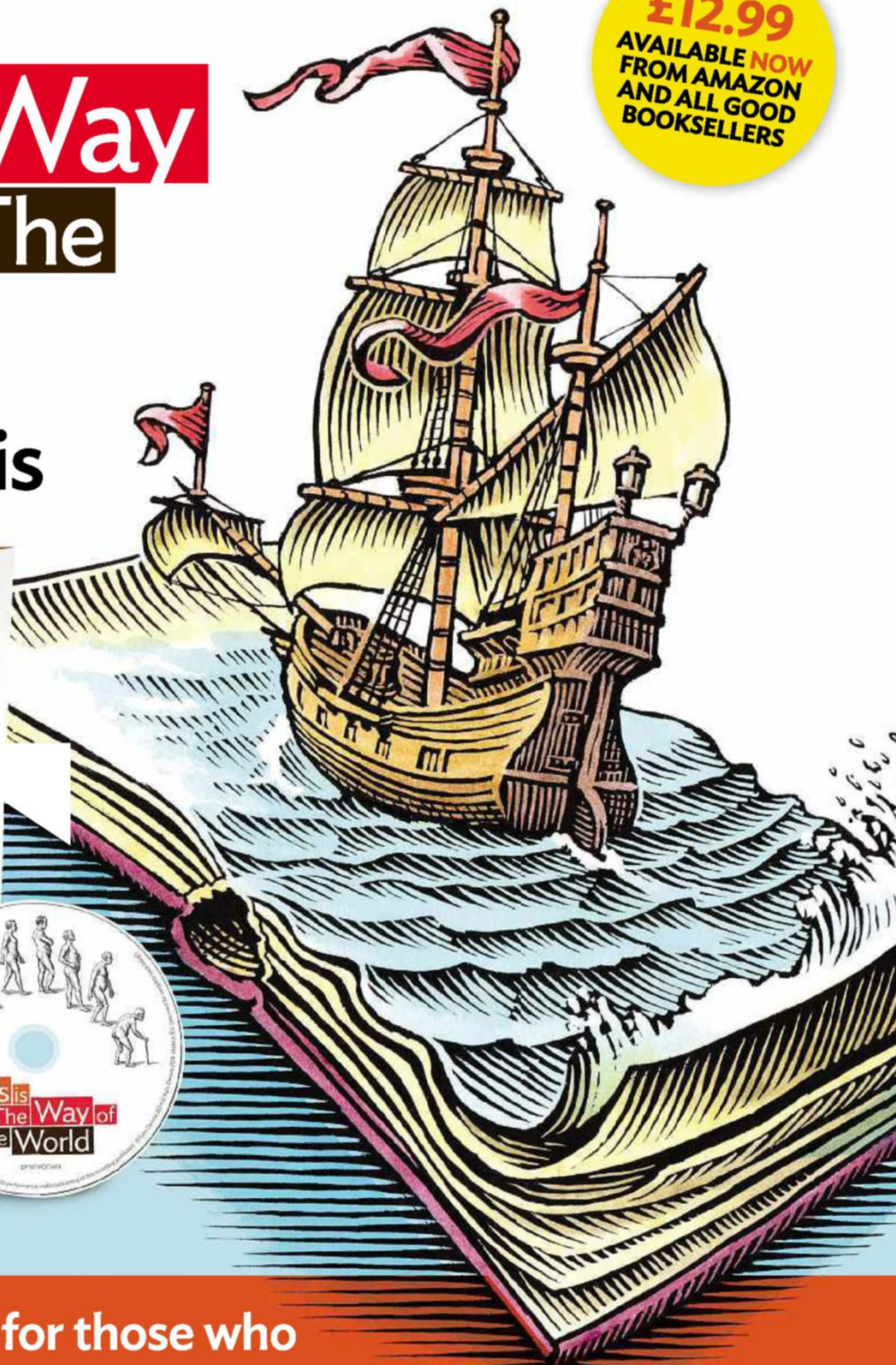
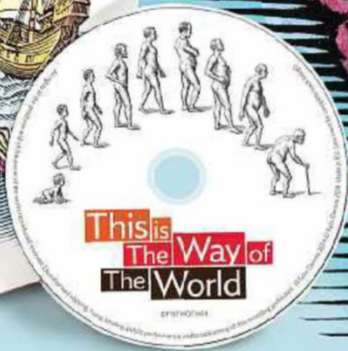
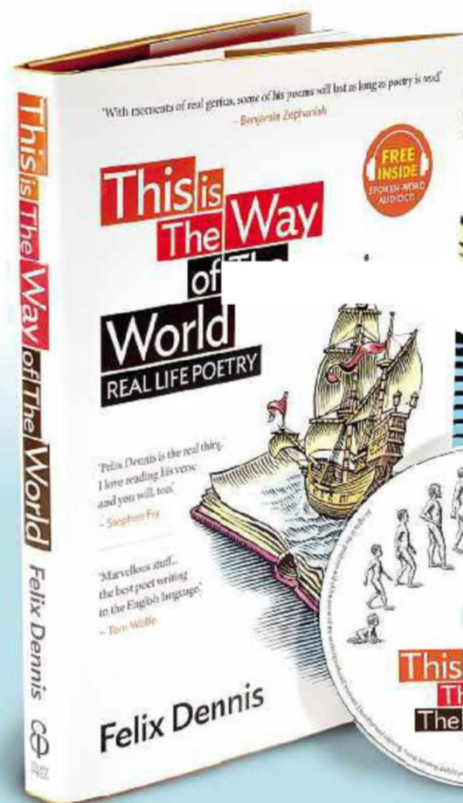
'With moments of real genius, some of his poems will last as long as poetry is read.'

– Benjamin Zephaniah

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**A book of poems for those who
don't read poetry** (as well as for those who do!)

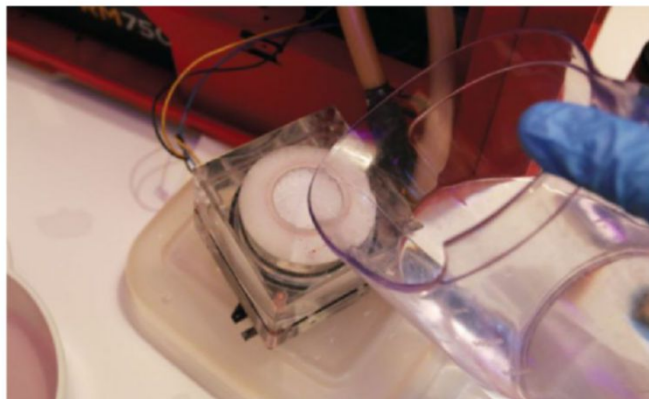
A collection of 'real life' poems by Felix Dennis, one of Britain's best-loved poets, charting life's course from infant to endings with illustrations by Bill Sanderson.

www.felixdennis.com contains many poems, published and unpublished, as well as a library of sound recordings and video footage of Felix Dennis's verse and poetry tours.



16 / MIX MAYHEMS PART 2

The Part 2 mix needs a different concentration, and also uses a different acid, so be sure to follow the instructions to create the right amount. Again, use the protective gloves and glasses while you mix the solution, and work in a location where spills won't be a problem.



17 / FILL SYSTEM

With the system completely drained and reconnected, add some Blitz Part 2 solution to the loop, checking for leaks as you go. Make sure all the power connectors are removed so that only the pump will be powered on.



18 / USE ATX JUMPER

Use an ATX jumper to power on the PSU and pump only. The kit doesn't include one so you'll need to buy it separately. Alternatively, you can short-out the green pin cable on your PSU's ATX connector and either of the black ground pins next to it with a short length of wire.



19 / BLEED AIR FROM SYSTEM

With the system on and the pump on full speed, fill the loop as you would normally, continually adding the Blitz 2 solution. It will foam up quite a lot, so you'll need to take your time and ensure the system is fully bled of air, tilting your PC to remove bubbles if necessary.



20 / RUN FOR 24 HOURS

Leave the system on a surface where spills or leaks won't be an issue, and allow the pump to run for 24 hours. We also recommend wrapping tissue around the joints, just in case there's a leak.



21 / CLEAN FILTERS

After 24 hours, check the filter. You may find there's detritus in it, in which case you'll need to wash it to clean off the debris, and to remove the cleaning solution. Leave it to one side and reinsert it once you've refilled the system.



22 / DRAIN SYSTEM

Now go ahead and drain the system. You'll need to disconnect each component individually, as flushing the whole loop may not remove all of the Blitz solution. Wash each component with deionised water.



23 / FLUSH WITH DEIONISED WATER

Connect the components again. You can now either repeat the process of filling and flushing each component a couple of times with deionised water, or you can continually fill the reservoir while draining its inlet into a bucket, to flush out the remaining Blitz solution.



24 / ADD BUFFER SOLUTIONS TO WATER

You now need the Mayhems kit's pH meter, but you'll have to calibrate it to ensure accuracy. Buffer solutions are included in the kit, which create specific pH levels using a certain amount of water. Create both solutions then clean the end of the sensor in water.



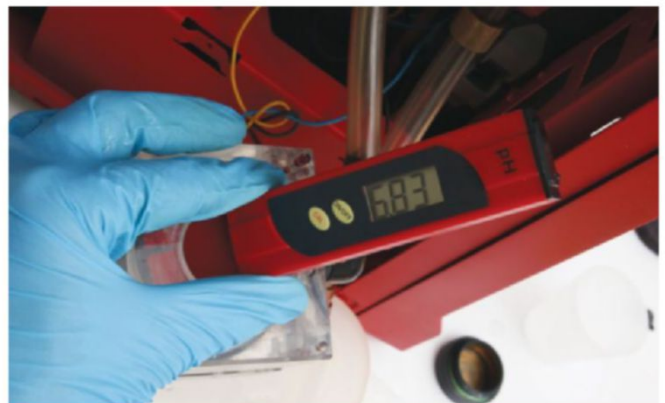
25 / CALIBRATE USING BUFFER SOLUTIONS

The pH sensor allows you to check the pH level in the system once you've drained it. Once you've flushed the system, place the sensor in the pH6 and pH4 buffer solutions and press the Calibrate button each time, cleaning the sensor with water in between these tests.



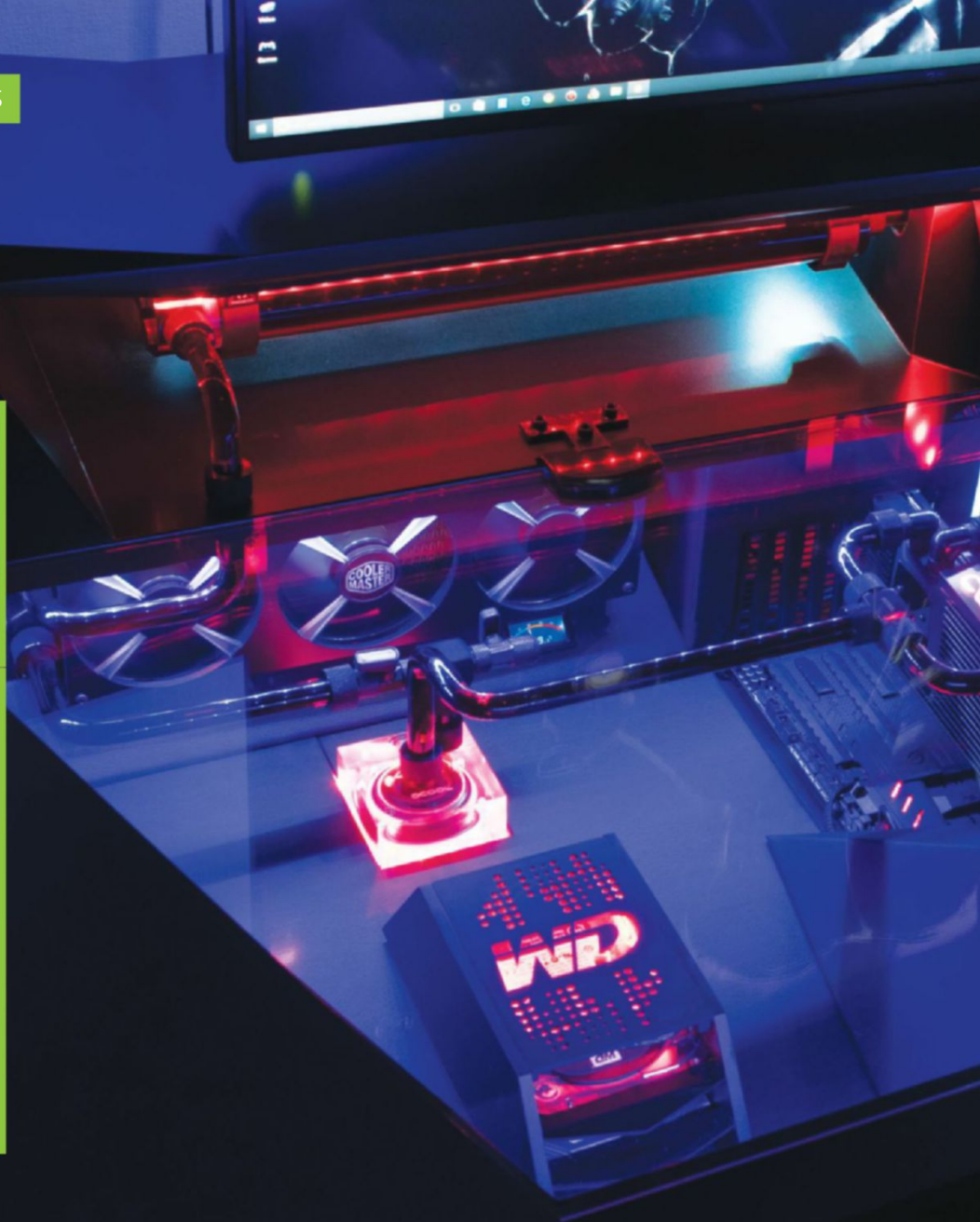
26 / CHECK SENSOR WORKS

Check the sensor by testing it in each of the corresponding pH solutions again, and also in tap water, which is usually between pH6-8. Now fill the system one last time with deionised water.



27 / CHECK pH LEVELS

Power the pump for ten minutes to circulate the coolant, and test it with the pH sensor. It should be around pH7 – ours was pH6.83. You can now add your own anti-corrosion and anti-microbial additives, or drain the system and use your own coolant as normal. **CPC**

**/MEET THY MAKER****Name** Robert Deluce (Deblow)**Age** 40**Location** Huddersfield**Occupation** Printer and graphic artist**Main uses for PC** Gaming, watching shows such as Game of Thrones, photo and video editing, social media and general web browsing**Likes** Movies, TV shows, art and drawing, console and PC gaming, comics, motorbikes, and collecting statues and figures of my favourite characters and monsters from movies and games**Dislikes** Currants and sultanas, depressing TV soaps, needles, cricket and not having a Dislike button on Facebook

Readers' Drives: Alternate

Robert Deluce took inspiration from Batman's Tumbler Batmobile and Honda's CBR600RR motorbike, and constructed this stunning desk build, complete with hard water-cooling tubing and 4K gaming abilities

CPC: What originally inspired you to build Alternate?

Robert: Some of the design inspiration came from my love of motorcycling; one of my favourite bikes is the Honda CBR600RR – I love its shape and angles, along with shape of most Lamborghinis. Meanwhile, Batman's Tumbler Batmobile inspired the paint job and the overall feel of the desk.

Some of the overall inspiration also came from the great responses and comments on forums and my social pages, which helped to build my confidence throughout the whole project.

I used the name 'Alternate', as this desk was an alternative design to my last desk, and different to most of the other desk builds at the start of 2014, when I started planning.

I built my last desk PC because I wanted better airflow than I could get from my standard PC case, and it's the same with Alternate. I also wanted to make the design as symmetrical as possible, which meant having the motherboard at the front and centre, which I hadn't seen done before. With my last desk build, I also found that when the PC was off and the LEDs went out, the desk just looked boring.

**SEE THE FULL
PROJECT LOG:**
[http://tinyurl.com/
ProjectAlternate](http://tinyurl.com/ProjectAlternate)



The main purpose of Alternate's design was to have a desk that looked the part even when all the lighting wasn't powered on—I wanted it to catch natural light with its sharp angles, which would then create depth and a strong presence. It's a little like having a nice car—you want it to still look nice when it's parked. I also wanted to position the reservoirs directly under the monitor, as the water in combination with the lighting creates a nice relaxing effect, although it's unfortunately hard to capture with photos.

CPC: What specs did you choose?

Robert: I spent months deciding on the CPU and GPU I wanted to use. I was looking at getting two Nvidia GeForce GTX 970s but, as I wanted to build a 4K gaming system, and spend some cash on upgrading my

screen from 2,560 x 1,440 to 4K, I decided on the Asus R9 295X2—the timing was perfect, as the 295X2 had just dropped in price to a reasonable £490 inc VAT. For my CPU, I put a Core i7-5820K in my Asus Sabertooth X99 board, as the single 295X2 card wouldn't need all the extra lanes of the Core i7-5930K anyway, so I saved myself £100.

With the exception of Batman, all my games can easily run at 60fps at 4K on either Very High or Ultra settings. I never planned to go overboard on the specs, even though I had some help from sponsors—I kept the specs reasonable, balancing price and performance rather than just buying to most expensive and powerful parts available.

CPC: What other mods have you built?

Robert: I've built two desk PCs previously. I built the first one in 2002 and it was very basic. I built the next desk rig in 2013/14, but this time I spent a little more time and money on it. I also followed the growing trend of encasing the components, along with all the water-cooling parts, within the desk.

I've also created five computer case mods in the past. The first PC case I modded was in 2001, before windowed cases were readily available and the majority of PC cases were cream-coloured. I installed windows in the side and top of the case, along with fans and USB ports, then painted the case black and added neon wire lighting, along with internal tube lighting.



CPC: What difficulties did you come across?

Robert: Creating the angles was stressful, but with practice and lots of patience, I finally got the result I wanted by sanding them into shape instead of cutting them. My biggest problem was finding a way to paint the desk without moving it far, which I solved by turning my shed into a paint shop. I covered the shed with plastic sheeting and used house fans to reduce fumes – I could then work with breathing gear in ten-minute bursts.

CPC: What tools did you use?

Robert: A hammer, screwdrivers, hand saws and so on. I also used my routers for cutting metal and plastic, shaping wood and cleaning. I bought a table saw specifically for this build too, which made cutting large pieces far easier than when I used a hand saw on the previous desk PC. I also purchased a large compressor, paint gun and other paint-related parts so I could paint the desk as professionally as possible. It was quite easy to get familiar with the table saw and the compressor, as the latter was just a larger version of an airbrush kit.

CPC: How long did the build take?

Robert: If you don't count the design stage, I spent eight months building and painting the desk. The reason it took so long was partly due to waiting for parts to arrive and mostly because my right leg has been broken for almost four years. Because of my broken leg and having to use crutches to get



around, I had to get help from my wife and friends whenever I needed to move large or heavy parts around the shed. I also had to spend some time in hospital after two operations and lastly, but most importantly, my son was born halfway through the build.

CPC: What did you learn from the build process?

Robert: I learned how to work with MDF – how to treat, cut and join it to make it last long. I also did lots of research on car-painting techniques, and received helpful advice from the guys at Graham Blades, one of the body repair shops I've used in the past. They helped with planning and recommending the best paints for the job, as well as advising me on the best breathing gear to use – the 2K paints I used are very toxic, and as they were matt, there was no room for error or a second attempt. Alternate was also

my first project to use hard water-cooling tubing, and setting it up was tricky at the start, especially because of the desk's design.

CPC: Are you happy with the end result, and is there anything you'd do differently if you built it again?

Robert: I'm happy with the end result. The size and shape was constantly changing throughout the build to make sure I could sit comfortably at the desk and use it in a functional way.

As for what I'd do differently, I would have planned the motor placement for the glass-top lift a little better if I'd known I was going to use a motor – I would have used two smaller motors on each side of the desk instead of one big one.

However, due to the space available and the angle of the glass, my only option was to go with a bigger motor that lifts the glass from directly underneath. **CPC**

BE A WINNER

To enter your machine for possible inclusion in Readers' Drives, your mod needs to be fully working and, ideally, finished based in the UK. Simply log on to www.bit-tech.net and head over to the forums. Once you're there, post a write-up of your mod, along with some pics, in the Project Logs forum. Make sure you read the relevant rules and advice sticky threads before you post. The best entrant each month will be featured here, where we'll print your photos of your project and also interview you about the build process. Fame isn't the only prize; you'll also get your hands on a fabulous selection of prizes – see the opposite page for details.

SYSTEM SPECS

CPU Intel Core i7-5820K

Graphics card Asus Radeon R9 295X2

Memory 32GB Avexir Blitz 1.1 DDR4

Motherboard Asus Sabertooth X99

Storage 6TB Western Digital Green 6TB, 2 x 2TB Seagate Barracuda, 1TB Western Digital Green, 2 x M.2 Samsung Evo 850 250GB

PSUs Cooler Master V1200 Platinum and G750M

Cooling Alphacool NexXoS XP³ Light CPU waterblock, Alphacool NexXoS GPX GPU waterblock, 2 x Alphacool VPP655 pumps, 2 x Phobya 450 reservoirs, 2 x Phobya G-Changer 360 RADs V.2 radiators, 16mm Alphacool hard tubing, Alphacool and Phobya hard tube fittings, Cooler Master Jet flow 120 and Silencio FP120 PWM cooling fans

Win all these prizes!

We've teamed up with some of the world's leading PC manufacturers and retailers to offer this great range of prizes to each lucky Readers' Drives winner. If your creation is featured in the magazine then you'll walk away with all of the prizes listed on this page, so get in your entries!

Corsair graphite Series 230T case and RM 550w Modular power supply

TOTAL VALUE £150 inc VAT / **MANUFACTURER** www.corsair.com

Corsair believes that a great PC starts with a great case. The Corsair Graphite Series 230T is a compact expression of this core philosophy. With stylish looks and a choice of three different colours, it packs in a remarkable number of features to provide builders with tonnes of room for expansion and amazing cooling potential. Like all Corsair cases, it's built using the finest materials and finished to the highest standards, so it will withstand several years of upgrades. Plus, to make sure it stand out from the crowd, the 230T features Corsair's new Air Series LED high-airflow fans, providing distinctive lighting with low-noise, high-airflow cooling.

Just as a quality case is essential to building a quality PC, a high-performance, a high-quality power supply is also a vital ingredient. The all new RM series has been built from the ground-up to deliver unmatched reliability alongside 80Plus Gold efficiency, and all with the absolute minimum of noise. It uses specially optimised quality parts to reduce sound at the component level, and it's completely silent below 40 per cent load, thanks to its Zero RPM fan mode. It's also fully modular, allowing for the maximum amount of flexibility during installation. With a Corsair Graphite 230T case and an RM 550W Modular power supply at the heart of your build, you'll have the foundations for a truly awesome gaming machine.



Mayhems coolant and dyes

VALUE £50 inc VAT / **MANUFACTURER** www.mayhems.co.uk



Cooling performance is only one part of the equation when it comes to kitting out your rig with custom water-cooling gear. The other major bonus is that all those tubes and gleaming fittings just make your PC look damn sexy, and they look even better when they're pumped full of fancy coloured coolant. As such, we're particularly pleased to have the folks at Mayhems now on board with Readers' Drives; they're currently offering two 1-litre bottles of Mayhems' Pastel Ice White coolant, along with a selection of five dyes, so you can choose the colour that best complements your PC. Check out the blue coolant in our own mini PC mod on the cover of Issue 109 for an example of what's possible with some Mayhems coloured coolant.

Phobya Modding Kit

VALUE £50 inc VAT **MANUFACTURER** www.phobya.com, www.aqua-tuning.co.uk

The Phobya modding kit is designed with the modder in mind, offering great value for money and quality products. The kit includes Nano-G 12 Silent Waterproof 1,500rpm multi-option fans, which use an innovative fan-blade design. As standard, the fans include braided black cables to keep your case looking as neat as possible. The fans are also supplied with a special cable that lets you run the fan at 5V rather than 12V, reducing the noise emitted in order to help you to build a silent system.

The kit also includes the 60cm Phobya 3-pin Molex to 4x 3-pin Molex Y-cable. This pre-

braided extension cable gives you extra routing options in your case, and it also enables you to run up to four fans from one compatible

motherboard header. Meanwhile, the Phobya SATA 3 cables included in the kit offer the same great quality braiding as the rest of the Phobya range, while also securing your connection with latched connectors.

As well as this, the kit includes the Phobya SlimGuide Controller, which gives you the option to vary the speed of other fans in your case, while the Phobya TwinLEDs let you shine a light on your mods.



CUSTOM PC

REALBENCH 2015

in association with 

Give your PC a workout with our new benchmark suite, and see how your rig compares to other readers' machines

BENCHMARK YOUR PC

Download the benchmarks from www.asus.com/campaign/Realbench and, before you run them, disable any power-saving technologies in your BIOS that change your CPU clock speed, or the leaderboard won't record your overclock frequency properly. To post a score on the leaderboard, go to Save Upload File in the RealBench 2015 app's Results menu, and save your results in an RBR file. You need to select Offline Uploads on the leaderboard site, sign up for an Asus account and upload your file.

Gimp

We use Gimp to open and edit large images. Unlike our previous Gimp test, this one uses more than one CPU core, although it's still more sensitive to clock speed increases than more CPU cores.

Handbrake H.264 video encoding

Our heavily multi-threaded Handbrake video encoding takes full advantage of

many CPU cores, pushing them to 100 per cent load.

LuxMark OpenCL

This GPU compute test is the only synthetic part of our suite, although the renderer is based on the real LuxRender physically based rendering software. As 3D rendering is a specific workload that not everyone will use, and because OpenCL support isn't standard in most software, this section is given just a quarter of the weighting of the other tests in the final score.

Heavy multi-tasking

Our new multi-tasking test plays a full-screen 1080p video, while running a Handbrake H.264 video encode.

On an Intel system, the 100 per cent reference score comes from a stock-speed Core i7-4790K, with 16GB of Corsair 2,400MHz DDR3 memory, a 240GB OCZ 150 SSD, an Asus Maximus Gene VII motherboard and an Nvidia GeForce GTX 780 3GB graphics card.

On an AMD system, the 100 per cent reference score comes from a stock-speed A10-7850K APU, with 8GB of Corsair 2,133MHz DDR3 memory, a 256GB Plextor M5 Pro SSD and an Asus A88X-Pro motherboard, using the APU's integrated graphics. **CPC**

SHOUT OUTS!

First congratulations this month go to richardnpaul, who has taken a different approach to conquering our leaderboard, using a Xeon E5 2670 system, and hitting number 11. Meanwhile, Chris.Waddle has upped his game with a new system score of 221,477, and new entry mikey has hit the 18 spot with a Core i7-5960X rig.

CHROME WARNING

At the moment, Google's Chrome browser flags up the RealBench 2015 download as potentially harmful, and we're aware of this issue. The file is perfectly safe, however – please ignore this warning.

CUSTOM PC REALBENCH 2015 LEADERBOARD

| RANK | SYSTEM SCORE | REFERENCE | USERNAME | MOTHERBOARD | CPU | CPU CLOCK | MEMORY | PRIMARY GPU |
|------|--------------|-----------|------------------|------------------------|---------------------|--------------|-----------------------|----------------------------|
| 1 | 275,683 | 240.9% | 8pack | Asus Rampage V Extreme | Intel Core i7-5960X | 5.5GHz | 16GB Kingston 3000MHz | Nvidia GeForce GTX Titan X |
| 2 | 233,375 | 203.9% | ian.parry3 | Asus Rampage V Extreme | Intel Core i7-5960X | 4.6GHz | 32GB G.Skill 3200MHz | Nvidia GeForce GTX Titan X |
| 3 | 221,477 | 193.5% | Chris_Waddle | Asus Rampage V Extreme | Intel Core i7-5960X | Not reported | 16GB Corsair 2666MHz | Nvidia GeForce GTX Titan X |
| 4 | 219,415 | 191.7% | Luke@DinoPC | Asus Rampage V Extreme | Intel Core i7-5960X | 4.6GHz | 16GB Corsair 3276MHz | Nvidia GeForce GTX Titan X |
| 5 | 215,694 | 188.5% | dubai1 | Asus X99-Pro/USB 3.1 | Intel Core i7-5960X | 4.7GHz | 32GB Corsair 2800MHz | Nvidia GeForce GTX 980 Ti |
| 6 | 206,723 | 180.6% | stuart | Asus Rampage V Extreme | Intel Core i7-5960X | 4.41GHz | 16GB Corsair 3000MHz | Nvidia GeForce GTX 780 Ti |
| 7 | 201,446 | 176.0% | CustomPC | Asus Rampage V Extreme | Intel Core i7-5960X | 4.3GHz | 16GB Corsair 2666MHz | Nvidia GeForce GTX Titan X |
| 8 | 197,964 | 173% | Carbonleg | Asus X99-E WS | Intel Core i7-5960X | Not reported | 32GB Corsair 2400MHz | AMD Radeon R9 200 Series |
| 9 | 189,230 | 165.3% | shadowrayne | Asus Rampage V Extreme | Intel Core i7-5960X | 4.2GHz | 32GB Corsair 2133MHz | Nvidia GeForce GTX 980 |
| 10 | 185,219 | 161.8% | dax | Asus Rampage V Extreme | Intel Core i7-5960X | 3.97GHz | 32GB Corsair 2448MHz | Nvidia GeForce GTX 980 |
| 11 | 179,521 | 156.9% | richardnpaul | ASRock EP2C602 | Intel Xeon E5 2670 | 3.3GHz | 32GB Kingston 1866MHz | AMD Radeon R9 200 Series |
| 12 | 179,386 | 156.7% | mboogie | Asus Rampage V Extreme | Intel Core i7-5960X | 4.2GHz | 32GB Crucial 2133MHz | Nvidia GeForce GTX 980 |
| 13 | 175,745 | 153.6% | dis80786 | Asus Rampage V Extreme | Intel Core i7-5930K | 4.4GHz | 16GB Corsair 2666MHz | Nvidia GeForce GTX 970 |
| 14 | 173,154 | 151.3% | mark.gee93 | Asus Rampage V Extreme | Intel Core i7-5930K | 4.49GHz | 12GB Corsair 3168MHz | Nvidia GeForce GTX 980 Ti |
| 15 | 172,828 | 151% | mdottwo | Asus Rampage V Extreme | Intel Core i7-5820K | 4.4GHz | 16GB G.Skill 2766MHz | AMD Radeon R9 200 Series |
| 16 | 167,332 | 146.2% | grozzie | ASRock X99M Killer | Intel Core i7-5930K | 4.48GHz | 32GB Kingston 3071MHz | AMD Radeon R9 200 Series |
| 17 | 167,002 | 145.9% | maliepaard.chris | MSI X99S SLI Plus | Intel Core i7-5820K | 4.49GHz | 16GB Corsair 3000MHz | Nvidia GeForce GTX 980 Ti |
| 18 | 165,635 | 144.7% | mikey | Asus Rampage V Extreme | Intel Core i7-5960X | Not reported | 16GB Corsair 2133MHz | Nvidia GeForce GTX 980 |
| 19 | 165,512 | 144.6% | Penfold | Asus X99-Deluxe | Intel Core i7-5820K | 4.5GHz | 32GB Corsair 2333MHz | AMD Radeon R9 200 Series |
| 20 | 163,650 | 143% | shaunhanson | MSI X99S SLI Plus | Intel Core i7-5820K | Not reported | 16GB Corsair 2133MHz | Nvidia GeForce GTX 980 |

Folding@Home

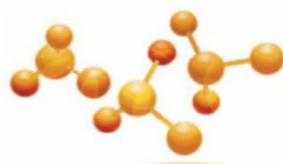
Join our folding team and help medical research

MILESTONES THIS MONTH

| USERNAME | POINTS MILESTONE | USERNAME | POINTS MILESTONE | USERNAME | POINTS MILESTONE | USERNAME | POINTS MILESTONE |
|------------------|------------------|----------------|------------------|-----------------|------------------|--------------|------------------|
| Anonymousfatchef | 60000 | Kentara | 600000 | Ganey | 4000000 | Sparkymatt | 20000000 |
| bradbooth | 70000 | roosauce | 700000 | kcanti | 4000000 | Unicorn | 20000000 |
| thecrazyeyes | 70000 | The_FFrey | 700000 | valkynaz | 4000000 | Qazax | 30000000 |
| Capt-Camm-Nett | 80000 | PatStar | 800000 | Clotten | 5000000 | madmatt1980 | 50000000 |
| whiskeyecho | 80000 | Rykard_Maximus | 800000 | QuasarGreg | 5000000 | pompeyrodney | 50000000 |
| wir3d123 | 90000 | TheTomBoy | 800000 | RaistlinRTCW | 5000000 | slowpurple | 50000000 |
| alexovich777 | 100000 | pIngu_666 | 900000 | kornvdd | 6000000 | Angy | 60000000 |
| PcShedTV | 100000 | bastardo_bill | 1000000 | RDL_Mobile | 6000000 | Petaflops | 60000000 |
| pig_farmer_uk | 100000 | GJBriggs | 1000000 | bigrew | 7000000 | Andy_J | 70000000 |
| crazeey | 200000 | mort6dav3 | 1000000 | davmonk | 7000000 | PS3/LanDi | 70000000 |
| CTHW | 200000 | LboroSlider | 2000000 | arcitech1 | 9000000 | Tattysnuc | 70000000 |
| PeteUKLancs | 200000 | smiler | 2000000 | b1ll55t34m | 9000000 | Cmaxx | 80000000 |
| Arcem | 300000 | Just_G | 3000000 | GreenDemon360 | 9000000 | Maglor | 90000000 |
| LEACHIE007 | 300000 | MrDevious | 3000000 | techknowledgey | 9000000 | Sean_Hayes | 90000000 |
| Bleakknave | 400000 | scoobyzilla | 3000000 | NikolaiDante | 10000000 | BeezaBob | 100000000 |
| FREE_WORLD | 400000 | varnis | 3000000 | _centurion_ | 20000000 | apeman556 | 200000000 |
| markf0wle | 400000 | weebob | 3000000 | Mark_Skelton | 20000000 | HHComputers | 900000000 |
| Albie1971 | 600000 | anfortis | 4000000 | Simlec | 20000000 | | |
| Anselm | 600000 | Bobthetoolnut | 4000000 | SirBenjaminNunn | 20000000 | | |

WHAT IS FOLDING?

Folding@home uses the spare processing cycles from your PC's CPU and graphics cards for medical research. You can download the client from <http://folding.stanford.edu> and our team's ID is 35947. Once you pass a significant milestone, you'll get your name in the mag. You can also discuss folding with us and other readers online at the www.bit-tech.net forums.



TOP 20 OVERALL

| RANK | USERNAME | POINTS | WORK UNITS |
|------|----------------|---------------|------------|
| 1 | Nelio | 2,506,264,051 | 164,950 |
| 2 | DocJonz | 1,710,205,767 | 184,903 |
| 3 | HHComputers | 910,384,022 | 36,148 |
| 4 | coolamasta | 845,857,436 | 178,654 |
| 5 | piers_newbold | 774,228,598 | 48,833 |
| 6 | Scorpuk | 745,880,705 | 31,954 |
| 7 | StreetSam | 571,113,589 | 90,231 |
| 8 | PC_Rich | 553,106,976 | 82,620 |
| 9 | johnim | 476,429,715 | 82,202 |
| 10 | Dave_Goodchild | 465,923,185 | 119,946 |
| 11 | Lordsoth | 447,024,464 | 99,232 |
| 12 | Slavcho | 422,439,290 | 36,498 |
| 13 | The_M2B | 362,325,504 | 61,430 |
| 14 | Laguna2012 | 346,668,174 | 25,332 |
| 15 | Desertbaker | 272,832,762 | 20,620 |
| 16 | phoenicis | 250,044,587 | 95,660 |
| 17 | KevinWright | 231,979,894 | 31,504 |
| 18 | TheFlipside | 221,684,701 | 23,278 |
| 19 | Wallace | 212,477,027 | 6,204 |
| 20 | zz9pzza | 211,014,628 | 15,794 |

TOP 20 PRODUCERS

| RANK | USERNAME | DAILY POINTS AVERAGE | OVERALL SCORE |
|------|---------------|----------------------|---------------|
| 1 | HHComputers | 5,721,648 | 910,384,022 |
| 2 | DocJonz | 4,047,371 | 1,710,205,767 |
| 3 | piers_newbold | 1,315,940 | 774,228,598 |
| 4 | Lordsoth | 1,277,175 | 447,024,464 |
| 5 | Laguna2012 | 1,129,522 | 346,668,174 |
| 6 | Scorpuk | 1,016,266 | 745,880,705 |
| 7 | PC_Rich | 920,539 | 553,106,976 |
| 8 | Desertbaker | 651,593 | 272,832,762 |
| 9 | madmatt1980 | 575,838 | 58,667,705 |
| 10 | KevinWright | 550,140 | 231,979,894 |
| 11 | BeezaBob | 517,490 | 100,490,900 |
| 12 | johnim | 504,794 | 476,429,715 |
| 13 | Maglor | 462,325 | 92,854,905 |
| 14 | Nelio | 453,383 | 2,506,264,051 |
| 15 | The_M2B | 425,408 | 362,325,504 |
| 16 | coolamasta | 424,469 | 845,857,436 |
| 17 | Roveel | 342,804 | 165,235,259 |
| 18 | Andy_J | 332,746 | 79,848,785 |
| 19 | apeman556 | 298,392 | 204,859,826 |
| 20 | Unicorn | 293,716 | 22,346,211 |



JAMES GORBOLD / HARDWARE ACCELERATED

NOW IS THE TIME TO UPGRADE

With little new from Intel, AMD or Nvidia on the horizon, now is the time to buy your gear, argues James Gorbald

At the risk of sounding like I'm writing an advert for my employer, there's never been a better time to upgrade your PC. While it's true that I work for one of the largest PC retailers in the UK, my argument isn't simply based on trying to increase sales, but on solid intel that there aren't many major product launches on the horizon.

On the CPU front, for example, Intel is now producing enough Skylake CPUs to start easing the shortage experienced last year and, as a result, the price difference between Skylake and Haswell chips has begun to narrow. Intel does have lots of products up its sleeves for later in the year, but in the near future, the only consumer launch is Broadwell E, which will replace Haswell E. Meanwhile, AMD hasn't launched any major new CPUs in recent years and has publically announced that its next-gen chips based on the Zen architecture won't be available until the second half of the year. In conclusion, Skylake is now a great and viable choice for most PC users, with Broadwell E waiting in the wings for anybody who really wants loads of CPU cores.

Likewise, 2015 was a hectic year for graphics, with lots of new and rebadged GPUs being launched, including the GeForce GTX 980 Ti and GTX 950, three Radeon Fury cards and a whole army of Radeon R9 300-series cards. After this flurry of launches, the dust has finally settled with only one rumoured graphics card on the near horizon – a Radeon card with dual Fury GPUs, although its undoubtedly high pricing, if and when it launches, means it will only be of interest to the same heavily walletted PC enthusiasts who are also waiting for Broadwell E. The only

real upset in the world of graphics is the imminent availability of VR headsets from Oculus and HTC, but as long as you have a fast enough GPU and a motherboard with plenty of free USB ports, Nvidia and AMD already have VR-compatible drivers.

Storage was also very eventful in 2015, with the mainstream debut of the horribly confusing M.2 interface, with support for SATA, AHCI and NVME PCI-E SSDs and some ludicrously fast Intel NVME SSDs in the form of PCI-E add-in cards. The whole SSD interface situation is much better now, with M.2 SATA SSDs taking a back seat in favour of much faster PCI-E drives, although

there's still room for improvement, with the capacity of the largest M.2 drives topping off at just 512GB. Larger M.2 drives will undoubtedly appear at some point, and the only other major development in storage is the release of the first SSDs with 3D XPoint memory instead of NAND flash. Realistically speaking, though, I wouldn't expect to see 3D Xpoint SSDs this side of the summer solstice.

Finally, with the release of Windows 10 and DirectX 12, there's nothing to worry about in terms of software compatibility, especially as Windows 10 is a free upgrade for PC enthusiasts who are already running Windows 7 or 8.

Of course, there will be other components coming out in the next few months, such as cases and coolers, before the big three (Intel, Nvidia and AMD) start a new launch frenzy in the second half of 2016, but coolers and cases are secondary components that don't directly, or as dramatically, affect performance. As such, if you're thinking about upgrading your core components or buying a new PC, now is a great time to think about it. **GPC**

There's only one rumoured graphics card on the near horizon – a Radeon card with dual Fury GPUs

James Gorbald has been building, tweaking and overclocking PCs ever since the 1980s. He now helps Scan Computers to develop new systems.



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